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Sumar

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Dynamic model and numerical approach for rotor-spun composite yarn spinning process

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REZUMAT – ABSTRACT

Model dinamic şi abordare numerică în procesul de filare cu rotor a firelor compozite

În lucrare sunt prezentate un model liniar dinamic al procesului de filare cu rotor a firelor compozite, prin analiza forței, şi abordările numerice ale modelului. Prin simularea traiectoriilor şi a diagramelor de fază pentru punctele de convergență a fibrelor scurte şi filamentelor, a fost obținută stabilitatea procesului de filare cu rotor a firelor compozite, utilă în îmbunătățirea eficienței producției. Studiul oferă o metodă generală de analiză a deplasării punctului de convergență în timpul procesului de filare cu rotor a firelor compozite.

Cuvinte-cheie: fire compozite, filare cu rotor, punct de convergență, model dinamic, simulare numerică

Dynamic model and numerical approach for rotor-spun composite yarn spinning process

In this paper, a linear dynamic model was established for rotor-spun composite yarn spinning process by force analysis. Numerical approach to the model was calculated. By simulating the trajectories and phase diagrams of convergent points of staple fibers and filaments, the stability of rotor-spun composite yarn spinning process was obtained, which is effective to improve the efficiency of production. The presented study provides a general pathway to understand the motion of convergent point during rotor-spun composite yarn spinning process.

Key-words: composite yarn, rotor-spun, convergent point, dynamic model, numerical simulation

Due to its high speed, big yarn package, cleaner condition and full automatization, rotor-spun spinning has been widely employed in textile industry [1–5]. However rotor-spun yarn has a relatively low breaking strength, which is still matter of concern [2–3]. By adding filaments during the spinning process the strength and characteristics of rotor-spun yarn can be highly improved. The filament reinforced rotor-spun yarn is called rotor-spun composite yarn [6]. The process of rotor-spun composite yarn has been studied intensively in recent years [6–9]. These researches are mostly focused on the structure and spinning techniques of rotor-spun composite yarn by experimental tests. However, the structure and characteristics of composite yarn depend mainly upon where and how the strands of fiber and filament are combined and mixed, which is hard to be observed directly as the high rotation speed of rotor. Thus theoretical models for the convergent point during rotor-spun composite yarn spinning process is extraordinary important and necessary.

Assuming the system is in a stable condition, the convergent points of various spinning parameters can be determined easily with our self-contained theoretical model [10–12]. Due to some perturbations, the convergent point keeps moving to an instantaneous new position which seriously affects the important quality index of yarns such as the evenness of structure and performance of rotor-spun composite yarn. In this paper, we established a linear dynamic model for rotor-spun composite yarn spinning process, and obtained numerical approach to the model, which could be used easily to evaluate the spinning process.

DYNAMIC MODEL

Figure 1 is a schematic diagram for rotor-spun composite yarn spinning process. The filament yarn from a supply bobbin is fed to the filament feed rollers under certain tension, and then is drawn into the rotor freely by air suction. In the rotor, the filament yarn is combined with a staple fiber strand and forms a composite yarn, which is drawn through the doffing tube and finally wound on to the take-up roller. The filament guide tube is positioned along the axis of rotating hollow rotor shaft.

Figure 2 reveals the dynamic illustration of rotor-spun composite yarn spinning process. The distances x and y are measured from the equilibrium position. OA is the strand of fibers, OB is the filaments and OC is the composite yarn. As shown in figure 2, B and C are in the same vertical line. Control volume D is chosen in such a way that the mass center coincides with the convergent point O of the fiber strand, filament and composite yarn. No matter the filament is rigid or flexible, they must be straight in the control volume as the results of their tensions [13].

By a simple geometrical analysis, component forces in x- and y-directions can be written as:

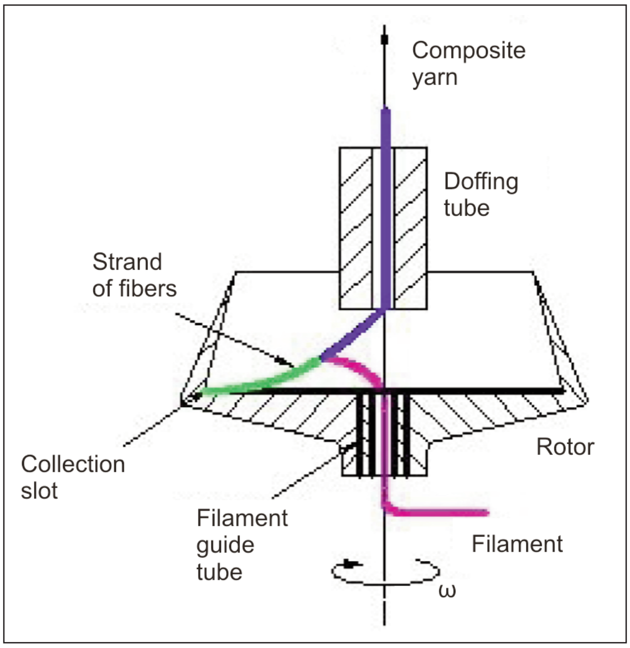

Fig. 1. Schematic of rotor-spun composite yarn spinning process

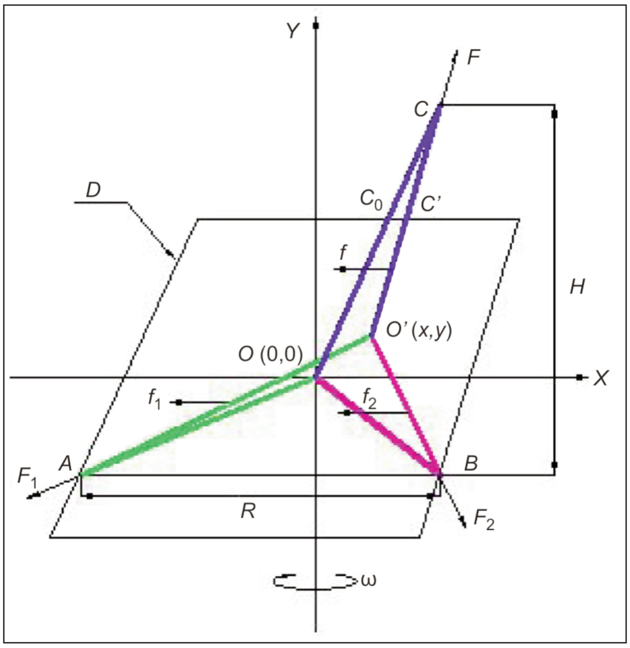

Fig. 2. Dynamic illustration of rotor-spun composite yarn spinning process

$$\begin{cases} \sum F_x = F_x - F_{1x} + F_{2x} - f_1 - f_2 - f = M\dfrac{d^2x}{dt^2} \\ \sum F_y = F_y - F_{1y} - F_{2y} = M\dfrac{d^2y}{dt^2} \end{cases} \quad (1)$$

where:

F_1, F_2, F are the tension of fiber strand, filament and composite yarn;

f_1, f_2, f – the centrifugal forces acting on the strand of fibers, filament and composite yarn;

M – the total mass of a fixed control volume which is determined from the relation (2)

$$M = \rho_1 l_1 + \rho_2 l_2 + \rho l \quad (2)$$

where:

ρ is the density per unit length of the resultant composite yarn;

l – the distance of the two-strand yarn below convergent point;

l_1, l_2, ρ_1, ρ_2 are length and density per unit length of the staple strand and filament above convergent point.

The centrifugal forces can be written in the forms (3):

$$\begin{cases} f_1 = m_1\,\omega^2 r_1 \\ f_2 = m_2\,\omega^2 r_2 \\ f = m\,\omega^2 r \end{cases} \quad (3)$$

where:

r_1, r_2, r are the rotating radius of the mass center for strand of fibers, filament and composite yarn.

As demonstrated in figure 2, the coordinates of A, B, C, C_0, O, O' and C' are, respectively, $(L–R, –h)$, $(L, –h)$, $(L, H–h)$, (x_0,y_0), $(0,0)$, (x, y) (4):

$$\left(\frac{x-L}{y-(H-h)}[y_0-(H-h)]+L, y_0\right) \quad (4)$$

Thus the expressions of r_1, r_2 and r is (5):

$$\begin{cases} r_1 = \dfrac{x-(L-R)}{2} + L - x = \dfrac{L+R-x}{2} \\ r_2 = \dfrac{L-x}{2} \\ r = L - \dfrac{x + \dfrac{x-L}{y-(H-h)}[y_0-(H-h)] + L}{2} \\ \quad = \dfrac{L - x - \dfrac{x-L}{y-(H-h)}[y_0-(H-h)]}{2} \end{cases} \quad (5)$$

L and h can be settled by our self-contained theoretical model [11].

Masses of the strand of fibers (m_1), filament (m_2) and composite yarn (m) can be expressed in the forms (6):

$$\begin{aligned} m_1 &= \rho_1 \cdot O'A = \rho_1\sqrt{(x-L+R)^2+(y+h)^2} \\ m_2 &= \rho_2 \cdot O'B = \rho_2\sqrt{(L-x)^2+(y+h)^2} \\ m &= \rho \cdot O'C' \\ &= \rho\sqrt{\left(\frac{x-L}{y-(H-h)}[y_0-(H-h)]+L-x\right)^2+(y_0-y)^2} \end{aligned} \quad (6)$$

By a simple geometrical analysis, components of forces in x- and y-directions can be written in the forms (7):

$$\begin{aligned} F_{1x} &= F_1 \cdot \frac{x-L+R}{\sqrt{(x-L+R)^2+(y+h)^2}} \\ &\approx F_1 \cdot \frac{R-L}{\sqrt{(R-L)^2+h^2}}\left(1+\frac{x}{R-L}-\frac{x(R-L)+yh}{(R-L)^2+h^2}\right) \end{aligned} \quad (7)$$

Similar expressions can be obtained for F_{2x}, F_x, F_{1y}, F_{2y}, F_y, f_1, f_2 and f.

Substituting equations (3) – (7) into equation (1) results in (8):

$$\begin{cases} \dfrac{d^2x}{dt^2} + Ax + By + k_1 = 0 \\ \dfrac{d^2y}{dt^2} + Cx + Dy + k_2 = 0 \end{cases} \qquad (8)$$

Here A, B, C, D, k_1 and k_2 are parameters getting from equations (3) – (7).

NUMERICAL APPROACH

To solve equation (8) here we hypothesize in equation (9):

$$\begin{cases} x = X + a \\ y = Y + b \end{cases} \qquad (9)$$

where:
a and b are real number.

Substituting equation (9) into equation (8), it is found equation (10):

$$\begin{cases} \dfrac{d^2X}{dt^2} + AX + BY + Aa + Bb + k_1 = 0 \\ \dfrac{d^2Y}{dt^2} + CX + DY + Ca + Db + k_2 = 0 \end{cases} \qquad (10)$$

The following formulae can be constructed equation (11):

$$\begin{cases} Aa + Bb + k_1 = 0 \\ Ca + Db + k_2 = 0 \end{cases} \qquad (11)$$

which can be written as equations (12) and (13):

$$a = \frac{k_2B - k_1C}{AD - BC} \qquad (12)$$

$$b = \frac{k_2A - k_1C}{BC - AD} \qquad (13)$$

So we have:

$$\begin{cases} \dfrac{d^2X}{dt^2} + AX + BY = 0 \\ \dfrac{d^2Y}{dt^2} + CX + DY = 0 \end{cases} \qquad (14)$$

Assuming one of the harmonic components [14] is:

$$\begin{cases} X = A_1 \sin(\omega t + \alpha) \\ Y = A_2 \sin(\omega t + \alpha) \end{cases} \qquad (15)$$

where:
A_1, A_2 and α are constants;
ω is a natural frequency of the system.

Substituting equation (15) into (14), dividing out the factor $\sin(\omega t + \alpha)$, and rearranging equation (14), we have equation (16):

$$\begin{cases} (A - \omega^2M)\, A_1 + BA_2 = 0 \\ CA_1 + (D - \omega^2M)\, A_2 = 0 \end{cases} \qquad (16)$$

Which are homogeneous linear algebraic equations in A_1 and A_2. The determinant $\Delta(\omega)$ of the coefficients of A_1 and A_2 is called the characteristic determinant. If $\Delta(\omega)$ is equated to zero, we can obtain the characteristic or the frequency of the system from which the values of ω are found, that is:

$$\Delta(\omega) = \begin{vmatrix} A - \omega^2M & B \\ C & D - \omega^2M \end{vmatrix} = 0 \qquad (17)$$

From linear algebra, equation (17) possesses a solution only if the determinant $\Delta(\omega)$ is zero.
Expanding the determinant and rearranging equation (17), it is found:

$$M^2\omega^4 - (A + D)\, M\omega^2 + (AD - BC) = 0 \qquad (18)$$

which is quadratic in ω^2.
This leads to two real and positive values for ω^2, calling them ω_1^2 and ω_2^2. The values of ω from equation (18), are $\pm\omega_1$, and $\pm\omega_2$, as shown in equation (19).

$$\begin{cases} \omega_1^2 = \dfrac{1}{2}\left[\dfrac{D + A}{M} + \sqrt{\dfrac{(D + A)^2}{M^2} - 4\dfrac{AD - BC}{M^2}}\right] \\ \quad = \dfrac{1}{2M}\left[(D + A) + \sqrt{(D - A)^2 + 4\,BC}\right] \\ \omega_2^2 = \dfrac{1}{2}\left[\dfrac{D + A}{M} - \sqrt{\dfrac{(D + A)^2}{M^2} - 4\dfrac{AD - BC}{M^2}}\right] \\ \quad = \dfrac{1}{2M}\left[(D + A) - \sqrt{(D - A)^2 + 4\,BC}\right] \end{cases} \qquad (19)$$

Since the solutions of equation (15) are harmonic, the negative signs for ω merely change the signs of arbitrary constants and would not lead to new solutions. Hence the natural frequencies are ω_1 and ω_2.
Substituting ω_1 and ω_2 in equation (16), and rearranging it, we obtain:

$$\begin{cases} R_1 = \dfrac{A_1^{(1)}}{A_1^{(1)}} = \dfrac{Y^{(1)}}{X^{(1)}} = -\dfrac{A - \omega_1^2 M}{B} = -\dfrac{B}{D - \omega_1^2 M} \\ R_2 = \dfrac{A_2^{(2)}}{A_2^{(2)}} = \dfrac{Y^{(2)}}{X^{(2)}} = -\dfrac{A - \omega_2^2 M}{B} = -\dfrac{B}{D - \omega_2^2 M} \end{cases} \qquad (20)$$

where:
R's are constants, defining the relative amplitudes of x and y at each of the natural frequencies ω_1 and ω_2.

Each of the solutions of equation (14) has two harmonic components at the frequencies ω_1 and ω_2, respectively. By superposition, the solutions from equation (15) are:

$$\begin{cases} \begin{Bmatrix} X^{(1)} \\ Y^{(1)} \end{Bmatrix} = \begin{Bmatrix} A_1^{(1)} \\ A_2^{(1)} \end{Bmatrix} \sin(\omega_1 t + \alpha_1) \\ \qquad = A_1^{(1)} \begin{Bmatrix} 1 \\ R_1 \end{Bmatrix} \sin(\omega_1 t + \alpha_1) \\ \begin{Bmatrix} X^{(2)} \\ Y^{(2)} \end{Bmatrix} = \begin{Bmatrix} A_1^{(2)} \\ A_2^{(2)} \end{Bmatrix} \sin(\omega_2 t + \alpha_2) \\ \qquad = A_1^{(2)} \begin{Bmatrix} 1 \\ R_1 \end{Bmatrix} \sin(\omega_2 t + \alpha_2) \end{cases} \tag{21}$$

Where the A's and α's are arbitrary constants. The relative amplitudes of the harmonic components in equation (21) are defined in equation (16):
Thus equation (20) becomes:

$$\begin{cases} X = A_1^{(1)} \sin(\omega_1 t + \alpha_1) + A_1^{(2)} \sin(\omega_2 t + \alpha_2) \\ Y = A_2^{(1)} \sin(\omega_1 t + \alpha_1) + A_2^{(2)} \sin(\omega_2 t + \alpha_2) \end{cases} \tag{22}$$

Substitute equation (9) into (22), we have:

$$\begin{cases} x = X + a = A_1^{(1)} \sin(\omega_1 t + \alpha_1) + A_1^{(2)} \sin(\omega_2 t + \alpha_2) + \dfrac{k_2 B - k_1 D}{AD - BC} \\ y = Y + b = A_2^{(1)} \sin(\omega_1 t + \alpha_1) + A_2^{(2)} \sin(\omega_2 t + \alpha_2) + \dfrac{k_2 A - k_1 C}{BC - AD} \end{cases} \tag{23}$$

where:
$A_1^{(1)}$, $A_1^{(2)}$, $A_2^{(1)}$, $A_2^{(2)}$, α_1 and α_2 are the constants of integration, which are determined by the initial conditions.

NUMERICAL SIMULATION

Under the conditions that radius of the rotor is 19 mm, rotation speed of the rotor is 60 000 rpm and the linear density of rotor-spun composite yarn is 58 tex/70 D, according to our quasistatic model [10], we can get $L = -12.53$, $h = 0.47$. If $y_0 = 0.42$, substituting these results into equation (23), we can get news equations as follows:

$$\begin{cases} x = -0.32 + 0.36 \cos 92422.13\, t - 0.05 \cos 8128.69\, t \\ y = 0.28 - 0.28 \cos 8128.69\, t \end{cases} \tag{24}$$

The phase diagram and trajectories of convergent point, can be obtained from equation (11) and (12) as plotted in figure 3.
As the phase diagrams and trajectories of convergent points under various spinning conditions are more stable, the performance of composite yarn will be better. Figure 4 demonstrates the trajectories of convergent points, as the ratio of filament speed to composite yarn rolled up speed is 0.91 to 1.09, which is the range of optimum speed ratio. Figure 5 reveals the phase diagrams of convergent points. Our numerical simulation results indicate that as the speed of filament yarn is closer to composite yarn's rolled up

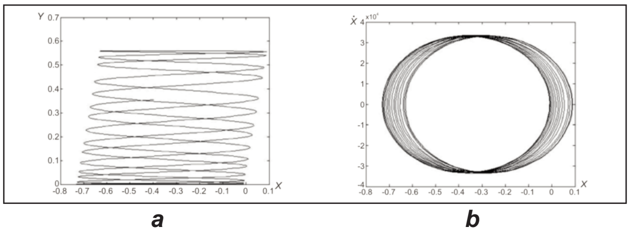

Fig. 3. Numerical simulation of convergent point (speed ratio is 1):
a – phase diagram; ***b*** – trajectory

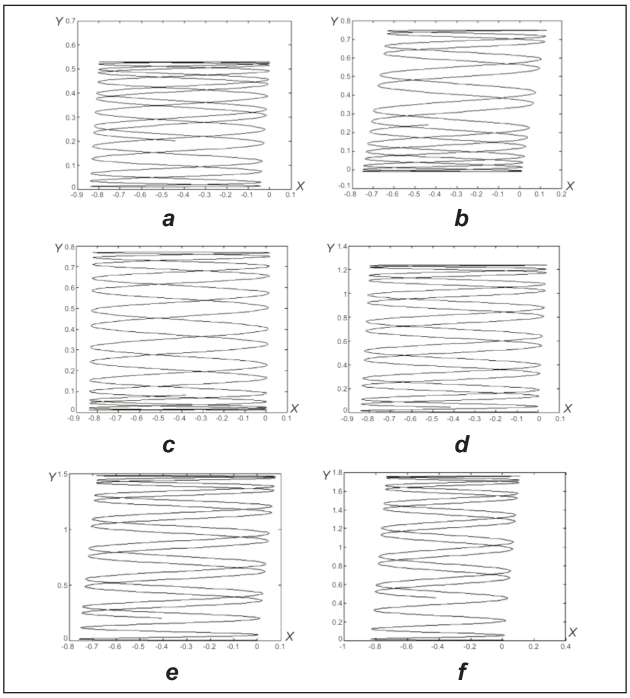

Fig. 4. Trajectories of convergent point, range of speed ratio:
a – 0.91; ***b*** – 0.94; ***c*** – 0.97; ***d*** – 1.03; ***e*** – 1.06; ***f*** – 1.09

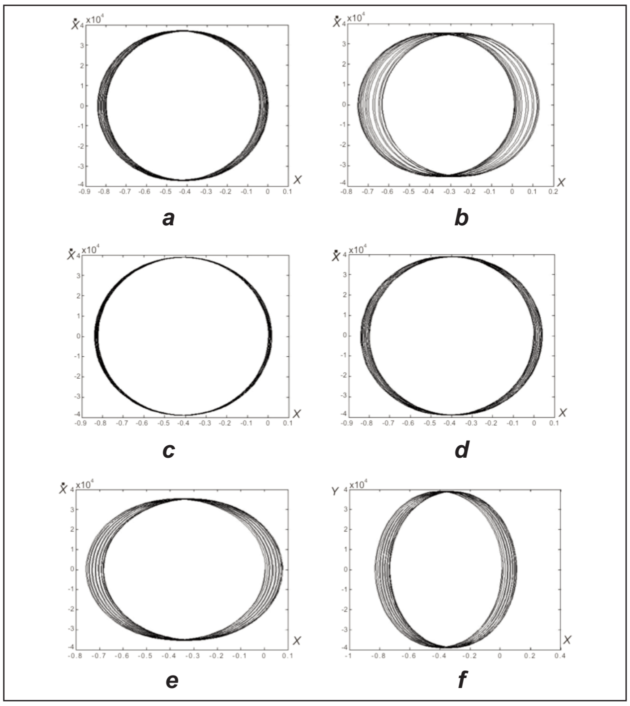

Fig. 5. Phase diagram of convergent point, range of speed ratio:
a – 0.91; ***b*** – 0.94; ***c*** – 0.97; ***d*** – 1.03; ***e*** – 1.06; ***f*** – 1.09

speed, convergent point is more stable, which means the performance of the composite yarn is more fit and fits very well with experimental results [9].

CONCLUSIONS

In this paper we proposed linear dynamic model and numerical approach for rotor-spun composite yarn spinning process. The presented model provides a general pathway to study the instability during rotor-spun composite yarn spinning process. By simulating the dynamic states of convergent points under various filament speeds, we got the conclusion that as the filament speed getting closer to that of composite yarn rolled-up, the spinning process will be more stable, which is very effective and useful for the production of rotor-spun composite yarn. The effects on characteristics of composite yarn when the rotor diameter, rotor-speed and count of fiber/filament changes could also be predicted by the dynamic model.

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Anthropometric parametres of children in Romania, result of the anthropometric survey carried out in 2010–2011

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REZUMAT – ABSTRACT

Caracteristici antropometrice ale copiilor din România, obținute în urma unei anchete antropometrice efectuate în anii 2010–2011

Lucrarea prezintă rezultatele unei anchete antropometrice efectuate asupra copiilor şi adolescenților, cu vârsta cuprinsă între 6 ani şi 19 ani, desfăşurată în România. Lucrarea oferă o bază de date ştiințifică, necesară elaborării standardului antropometric şi construcției tiparelor pentru îmbrăcăminte. Toate produsele utilizate sau purtate de populație în viața de zi cu zi trebuie să fie proiectate luând în considerare caracteristicile antropometrice ale utilizatorilor, pentru a obține cea mai bună măsură şi funcționalitate. Rezultatele analizei statistice a datelor antropometrice primare în raport cu grupele de vârstă şi sex, analiza creşterii staturale prin prisma modificărilor suferite de anumite segmente ale corpului, evoluția greutății şi a indicelui de masă corporală sunt prezentate sub formă de tabele şi grafice.

Cuvinte-cheie: copii, adolescenți, dimensiuni antropometrice, standard antropometric, mărimi corporale

Anthropometric parameters of children in Romania, result of the anthropometric survey carried out in 2010–2011

This paper presents the results of anthropometric survey of children and adolescents, aged between 6 years and 19 years, held in Romania. This paper provides a scientific database, required by the elaboration of the anthropometric standard and construction of patterns for clothes. All products used or worn by the population in daily life must be designed taking into account anthropometric characteristics of users for the best fit and function. Results of statistical analysis of anthropometric data in relation to primary age groups and sex, analysis of statural growth in terms of the modifications of certain parts of the body, weight and body mass index evolution are presented as tables and graphs.

Key-words: children, adolescents, anthropometric dimensions, anthropometric standard, body size

In the past, clothing for children was approached empirically, with no scientific correlation between body size and shape and size of product. Also, people didn't consider as important the functionality characteristics required by the specific products of this segment of the population. Later designing and manufacturing clothing for children was achieved starting from the adult scheme by reducing the proportions. Because clothing has an important role in daily life, the design and manufacture methodology must be correlated with high variability that a child records to transition from one growth period to another.

In conclusion, creating children's clothing with forms according to their body particularities revealed the following needs:

– development of specific databases for boys and girls;
– development of anthropometric standards for girls and boys;
– revision of the sizes systems specific to age groups;
– development of technical standards governing the control sizes of clothing.

The growth process of children should be considered in two ways: increasing stature and weight gain. Literature mentions different growth rates in the two sexes [1], namely:

– until the age of 6 years, both girls and boys have about the same height;
– from 6 years to 10 years girls grow faster than boys;
– between 10 and 13 years, girls maintain their ascendancy in the growth of stature (due to installation of puberty);
– after 13 years boys grow faster than girls.

The growing stature is required to be analyzed in terms of the modifications of certain body segments (head, thorax, limbs). Weight gain is the increase in mass with increasing body height and after the completion of stature growth, further body mass increase is due to fat deposits, respectively the modifications in the transverse direction of the body.

In Romania, the first legislative acts governing the size of type bodies for children and adolescents were developed in the years 1975–1980 as project standard without certification.

EXPERIMENTAL PART

Anthropometric survey

Obtaining a truly random sample of the population is difficult. Due to the very high spread of young age population, a truly random selection would have been prohibitive both in terms of time and money. In addition, there may be “self-selection” as option not to help, by refusing to grant permission for a child to be measured [2]. This is a constant, and those who express it exercise the right to refuse. Consequently, the sample was made up in different areas of Romania, the selection of places being made in order to obtain a good balance between cost and sampling requirements. The requirements included: a widespread of places, a mix of urban/rural, a mix of social and economic status of families and ethnic groups that is proportional to their representation in the population.

Because of the constraints, the sample covered all these aspects. There is no evidence that any of these factors has been fully considered in the sample or that any of the remaining imperfections affected the results systematically and significantly. The proposed objective was the total sample reflects the national picture. Therefore, measurements were made by 3D scanning in Bucharest, Galati, Brasov, Oradea, Focsani and Dobrogea. Schools and colleges were selected for investigation if children are from different ethnic groups and if most students come from rural areas. Measured subjects were boys and girls aged 6–19 years. Sample size was established based on simple statistical criteria, because there is no information about variations in sizes of children in our country at different ages. This was representative and the value was 0,1% of all children aged 6–19 years. The measurement schedule was limited by cost and time.

The equipment used to measure the child was the three-dimensional scanner (3D), constructed in accordance with EN ISO 20685:2005 “3-D scanning methodologies for internationally compatible anthropometric databases”. Data acquisition on the human body shape and size was made in accordance with ISO 7250 “Basic human body measurements for technological design” and ISO 8559 “Garment construction and anthropometric surveys – Body dimensions”.

The preparation of the anthropometric survey for children was laborious, requiring transmission of addresses to school inspectorates in recommending schools and high schools to investigate, addresses the schools, to request approval to perform anthropometric survey, addresses to parents to inform and obtain agreement to measure child and seeking the opinions of the Institute of Public Health on the use of the 3D Scanning System Antroscan to scan children. During the measurements, children responded to a questionnaire with questions necessary to evaluate the results, including: date of birth, computer using period, physical activity and food habits.

In the end, 2 900 children were scanned of which were retained for statistical processing only 1 375 boys and 1 476 girls.

RESULTS AND DISCUSSIONS

Statistical analysis of primary data

Primary anthropometric data were filtered by gender (girls and boys) and age group: 6–8 years, 9–11 years, 12–13 years, 14–15 years, 16–19 years.

Of the approximately 150 primary anthropometric dimensions, were selected and subjected to statistical analysis only the data requested by clothing designers and patterns builders (technicians) for sizing clothes [3]. A number of 35 anthropometric dimensions were selected for boys and 46 anthropometric dimensions for girls, which were processed statistically one-dimensional, according to the formulas described in the literature [4], determining:

- *Arithmetic media of selection (trend parameter, mean ($\bar{x}$)),* for the main dimensions of each age group. They characterized in a synthetic way, in one expression, which is essential, normal, typical and representative of the group;
- *Limits of variations string (x_{min} and x_{max}), standard deviation (S_x), dispersion (variance, S^2_x)* and *coefficient of variation (C_v),* indicators characterizing the size variation and its specificity;
- *Error limit of the selection average ($\Delta\bar{x}$)* and *test of selection average (t_{xm})* as indicators that characterize the population.

The distribution normality was verified by calculating the indicators: coefficient of asymmetry (Skewness, β_1) and coefficient of vaulting (Kurtosis, β_2). If the selection is statistically significant under statistic relation was verified by the student test $t_{student}$ (*t critic*) to a 95% confidence.

Statistical indicators of main anthropometric measurements and distribution normality by age and gender are presented in table 1 and table 2.

Analyzing the values of the anthropometric indicators in tables 1 and 2, the following issues were established:

- Coefficient of variation, C_v, for body height (I_c), has values below 10%, indicating a selection of high homogeneity, and for bust circumference (P_b), waist circumference (P_t), hips/circumference (P_s), C_v values are between 10% and 20% which indicates an average homogeneity. At higher ages, girls, C_v has values below 10% indicating a high homogeneity of the selection;
- For parameters I_c, P_b, both boys and girls and P_s for girls, the asymmetry coefficient (β_1) is around zero, indicating a normal distribution and the boys, being less than 3 indicates a distribution with negative asymmetry so the distribution curve is shifted to the left;
- Coefficient of vaulting (β_2) < 3 indicates a flat empirical distribution;

Table 1

Statistical indicator	Anthropometric measurements														
	Group 6–8 years			Group 9–11 years			Group 12–13 years			Group 14–15 years			Group 16–19 years		
	I_c	P_b	P_t	I_c	P_b	P_t	I_c	P_b	P_t	I_c	P_b	P_t	I_c	P_b	P_t
Average	127.979	65.192	60.460	141.404	71.637	65.507	156.401	79.081	69.705	168.958	87.591	73.351	173.993	93.442	76.261
Variant, S^2_x	48.093	66.868	63.300	70.235	112.958	107.268	78.431	104.951	97.678	71.421	100.886	88.391	46.420	65.749	66.103
Deviation std., S_x	6.935	8.177	7.956	8.381	10.628	10.357	8.856	10.245	9.883	8.451	10.044	9.402	6.813	8.109	8.130
Coefficient of variation, *Cv*	5.419	12.543	13.159	5.927	14.836	15.811	5.662	12.954	14.179	5.002	11.467	12.817	3.916	8.678	10.661
Test of average selection, *tx*	18.454	7.972	7.599	16.873	6.740	6.325	17.660	7.719	7.053	19.992	8.721	7.802	25.537	11.524	9.380
Sample, *N*	189	188	188	223	223	222	159	159	159	258	258	254	543	542	540
Minimum value, X_{min}	108.900	51.000	48.500	120.100	46.600	48.400	133.100	59.700	54.400	143.500	63.600	55.600	141.100	64.900	60.900
Maximum value, X_{max}	150.000	91.600	86.200	167.400	107.900	98.600	180.100	115.700	105.400	189.100	126.900	106.900	194.700	124.900	113.400
Degrees of freedom, *d.f*	188	187	187	222	222	221	158	158	158	257	257	253	542	541	539
Confidence, %	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
t critic, $t_{Student}$	1.973	1.973	1.973	1.971	1.971	1.971	1.975	1.975	1.975	1.969	1.969	1.969	1.964	1.964	1.964
Standard error	0.504	0.596	0.580	0.561	0.712	0.695	0.702	0.812	0.784	0.526	0.625	0.590	0.292	0.348	0.350
Skewness, β_1	0.128	0.913	1.042	0.032	0.907	1.047	–0.002	0.805	1.190	–0.391	0.487	1.015	–0.361	0.430	1.287
Kurtosis, β_2	–0.016	0.526	0.606	-0.047	0.967	0.562	0.100	0.792	1.343	0.133	0.568	0.734	1.112	0.808	2.398

STATISTICAL INDICATORS FOR CHARACTERIZATION OF ANTHROPOMETRIC MEASUREMENTS–BOYS

Table 2

Statistical indicator	Anthropometric measurements														
	Group 6–8 years			Group 9–11 years			Group 12–13 years			Group 14–15 years			Group 16–19 years		
	I_c	P_b	P_s	I_c	P_b	P_s	I_c	P_b	P_s	I_c	P_b	P_s	I_c	P_b	P_s
Average	127.523	61.809	70.114	141.970	72.384	79.029	156.470	84.439	90.059	160.199	87.922	93.725	161.223	89.956	95.980
Variant, S^2_x	59.935	64.450	55.101	80.946	80.946	75.026	49.167	90.227	83.599	39.460	62.012	59.735	45.601	57.200	49.669
Deviation std., S_x	7.742	8.028	7.423	8.997	10.362	8.662	7.012	9.499	9.143	6.282	7.875	7.729	6.753	7.563	7.048
Coefficient of variation, *Cv*	6.071	12.989	10.587	6.337	14.315	10.960	4.481	11.249	10.152	3.921	8.957	8.246	4.189	8.408	7.343
Test of average selection, *tx*	16.472	7.699	9.446	15.780	6.986	9.124	22.315	8.889	9.850	25.502	11.165	12.127	23.875	11.894	13.619
Sample, *N*	178	178	170	191	191	191	167	167	165	267	267	264	670	669	666
Minimum value, X_{min}	106.000	40.700	53.700	116.900	52.900	62.400	137.800	61.300	68.900	142.500	67.300	59.500	139.600	67.100	79.700
Maximum value, X_{max}	158.000	87.300	91.700	168.800	102.800	100.100	177.900	117.700	117.800	180.100	119.100	121.300	189.800	125.000	126.900
Degrees of freedom, *d.f*	177	177	169	190	190	190	166	166	164	266	266	263	669	668	665
Confidence, %	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
t critic, $t_{Student}$	1.973	1.973	1.973	1.973	1.973	1.973	1.974	1.974	1.974	1.969	1.969	1.969	1.964	1.964	1.964
Standard error	0.580	0.602	0.569	0.651	0.750	0.627	0.543	0.735	0.712	0.384	0.482	0.476	0.261	0.292	0.273
Skewness, β_1	0.594	0.866	0.634	0.199	0.295	0.316	–0.208	0.349	0.274	0.228	0.838	0.359	0.155	0.874	0.936
Kurtosis, β_2	1.320	1.043	0.301	–0.252	–0.536	–0.588	0.157	1.031	–0.075	0.075	1.881	1.804	0.647	1.777	1.579

STATISTICAL INDICATORS FOR CHARACTERIZATION OF ANTHROPOMETRIC MEASUREMENTS–GIRLS

- Comparing the test of average selection $t\bar{x}$ with the value of the "Student" test, was found finds that $t\bar{x} > t_{Student}$ which indicates a significant selection under statistical relation, the conclusions of analysis can be extended to the community in which it was drawn.

The main dimensions standardized

From statistical analysis of anthropometric data, their standardized measurements and average values were calculated. These are presented in tables 3–7. Graphic evolution of body height by gender and age is shown in figure 1. Note that the growth of stature record different rates of growth in both sexes: from 6 years to 13 years girls have a slightly ascending of growth; after this age boys grow faster than girls. Data obtained correspond to the information given in the literature.

Bust circumference

Evolution of bust/chest circumference by age and gender is shown in figure 2. If the age group 6–8 years chest circumference is greater in boys, with the entrance of puberty bust circumference increases for girls.

Body weight

For girls weight gain have a higher rate at puberty, that is exceeded by boys after the age of 14 years (fig. 3).

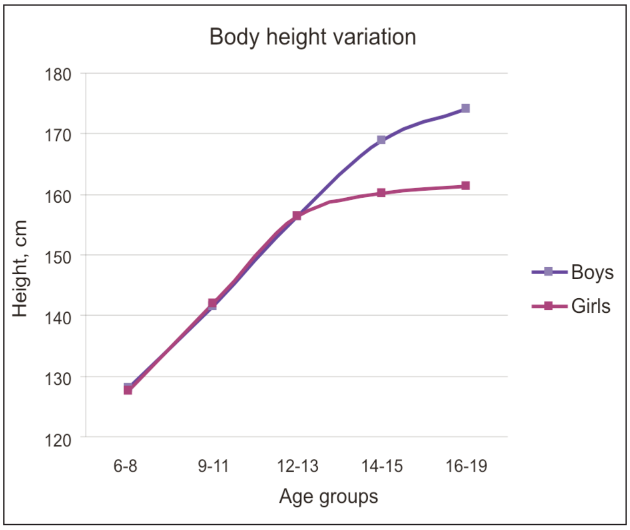


Fig. 1. Body height evolution of by age and gender

Table 3

MAIN STANDARDIZED DIMENSIONS FOR AGE GROUP 6–8 YEARS								
Anthropometric parameter	**Boys** *Value,* cm			**Average value,** cm	**Girls** *Value,* cm			**Average value,** cm
Body height, I_c	122	128	134	128,0	122	128	134	127,5
Chest/bust circumference - horizontal, P_b	61	65	70	65,0	58	62	66	62,0
Waist circumference, P_t	57	60	64	60,5	-	-	-	-
Hips maximum circumference, P_s	-	-	-	-	66	70	75	70,0

Table 4

MAIN STANDARDIZED DIMENSIONS FOR AGE GROUP 9–11 YEARS										
Anthropometric parameter	**Boys** *Value,* cm				**Average value,** cm	**Girls** *Value,* cm				**Average value,** cm
Body height, I_c	134	140	146	152	141,0	134	140	146	152	142,0
Chest/bust circumference - horizontal, P_b	66	71	75	80	71,5	67	71	75	79	72,0
Waist circumference, P_t	60	65	69	73	65,5	-	-	-	-	-
Hips maximum circumference, P_s	-	-	-	-	-	74	78	82	85	79,0

Table 5

MAIN STANDARDIZED DIMENSIONS FOR AGE GROUP 12–13 YEARS										
Anthropometric parameter	**Boys** *Value,* cm				**Average value,** cm	**Girls** *Value,* cm				**Average value,** cm
Body height, I_c	146	152	158	164	156,0	146	152	158	164	156,0
Chest/bust circumference - horizontal, P_b	73	77	80	84	79,0	79	82	85	89	84,0
Waist circumference, P_t	66	68	70	73	70,0	-	-	-	-	-
Hips maximum circumference, P_s	-	-	-	-	-	84	87	91	95	90,0

Table 6

MAIN STANDARDIZED DIMENSIONS FOR AGE GROUP 14–15 YEARS										
Anthropometric parameter	**Boys**				**Average value,** cm	**Girls**				**Average value,** cm
	Value, cm					*Value,* cm				
Body height, I_c	158	164	170	176	169,0	152	158	164	170	160,0
Chest/bust circumference - horizontal, P_b	81	84	88	92	87,5	85	87	89	92	88,0
Waist circumference, P_t	68	71	74	77	73,0	-	-	-	-	-
Hips maximum circumference, P_s	-	-	-	-	-	91	93	95	98	94,0

Table 7

MAIN STANDARDIZED DIMENSIONS FOR AGE GROUP 16–19 YEARS										
Anthropometric parameter	**Boys**				**Average value,** cm	**Girls**				**Average value,** cm
	Value, cm					*Value,* cm				
Body height, I_c	164	170	176	182	174,0	152	158	164	170	161,0
Chest/bust circumference - horizontal, P_b	90	92	94	96	93,5	88	89	91	92	90,0
Waist circumference, P_t	74	75	77	78	76,0	-	-	-	-	-
Hips maximum circumference, P_s	-	-	-	-	-	93	95	97	99	96,0

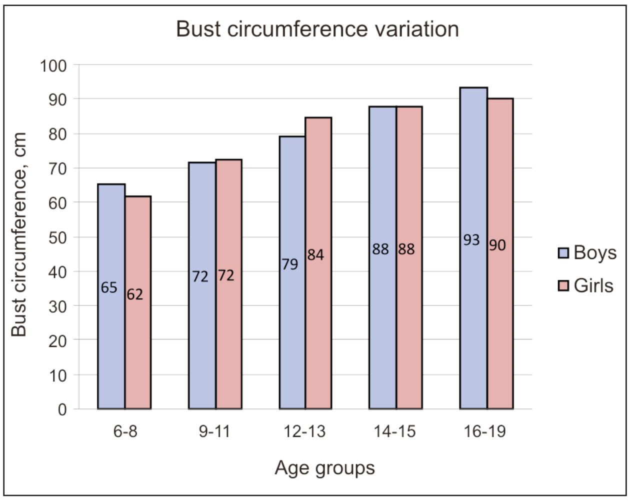


Fig. 2. The evolution of bust/chest circumference by age and gender

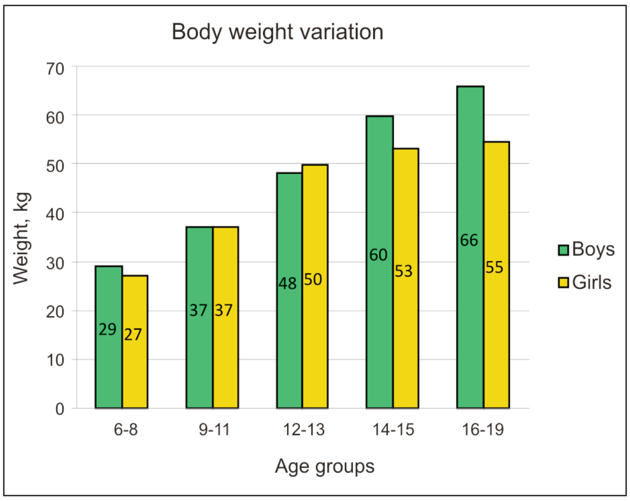


Fig. 3. Weight growth by age and gender

Evaluation of health through the analysis of anthropometric parameters

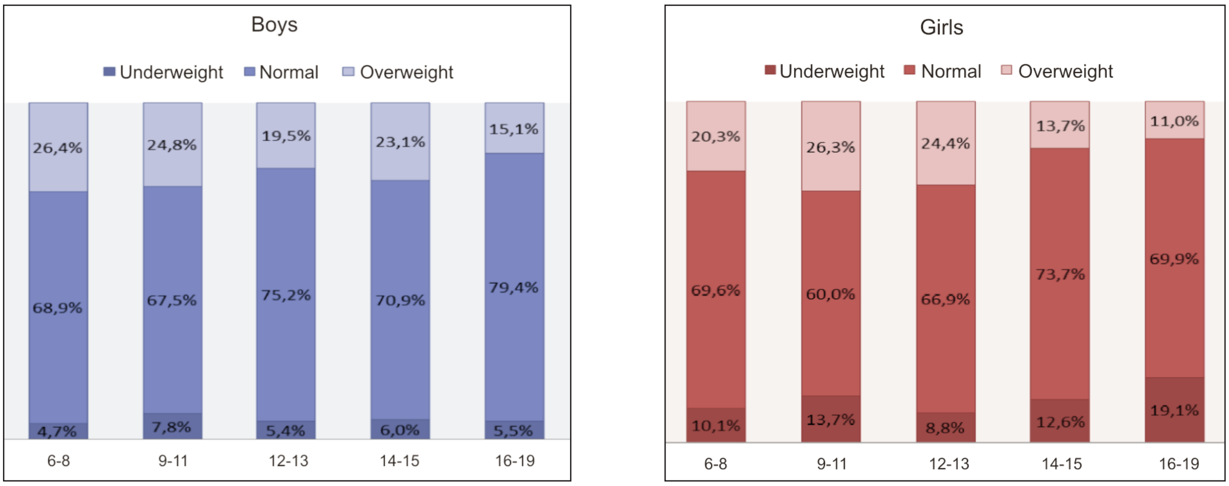
In the past, children's anthropometric measurements were made and used to assess growth and health. The main parameters used to assess children growth are weight depending on age and height depending on age.

It should be noted that in Romania are not available official growth curves based on the Romanian population study, so basically specialists are working with growth curves used in other countries (France, USA, Germany), starting from the wrong assumption that Romania's population would be similar to populations that led to the composition of growth curves. One of the indices is Body Mass Index (IMC or BMI). Based on data obtained in the anthropometric study and the curves used by the World Health Organization, we calculated BMI for the analyzed population sample. Results are shown in the diagrams of figure 4.

Measurement protocol analysis of a subject can give an indication of thorax torsion around a vertical axis with an angle expressed in degrees (fig. 5) the angle of the shoulder line – left/right (fig. 6). These problems can be identified in the protocol by the hips side length from waist to the buttocks – left/right (fig. 7).

CONCLUSIONS

Anthropometric parameters were the basis for elaborating the anthropometric standards needed in the process of clothing pattern design for children. In this moment, there are no anthropometric data from previous years, validated in terms of designing clothes, to appreciate their evolution over time.



a ***b***

Fig. 4. Assignment percentage of the body mass index for children by age and gender: ***a*** – boys; ***b*** – girls

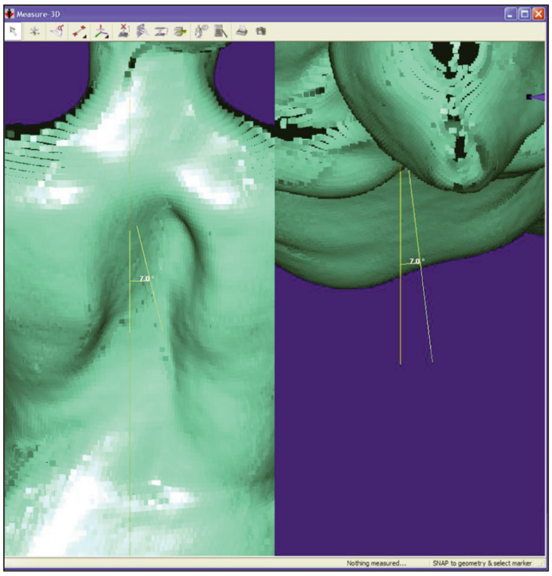


Fig. 5. Thorax torsion

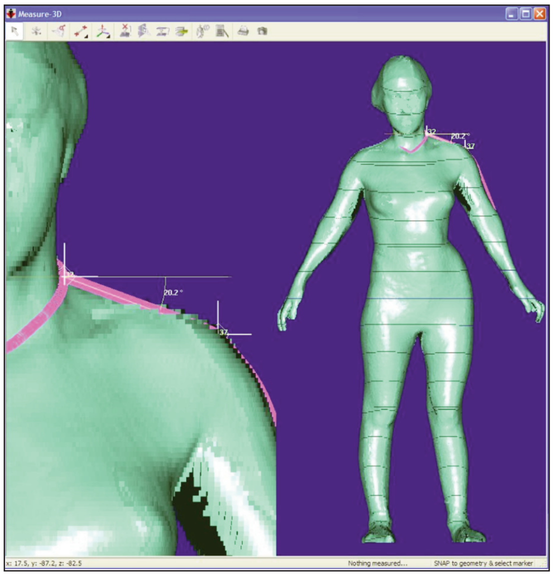
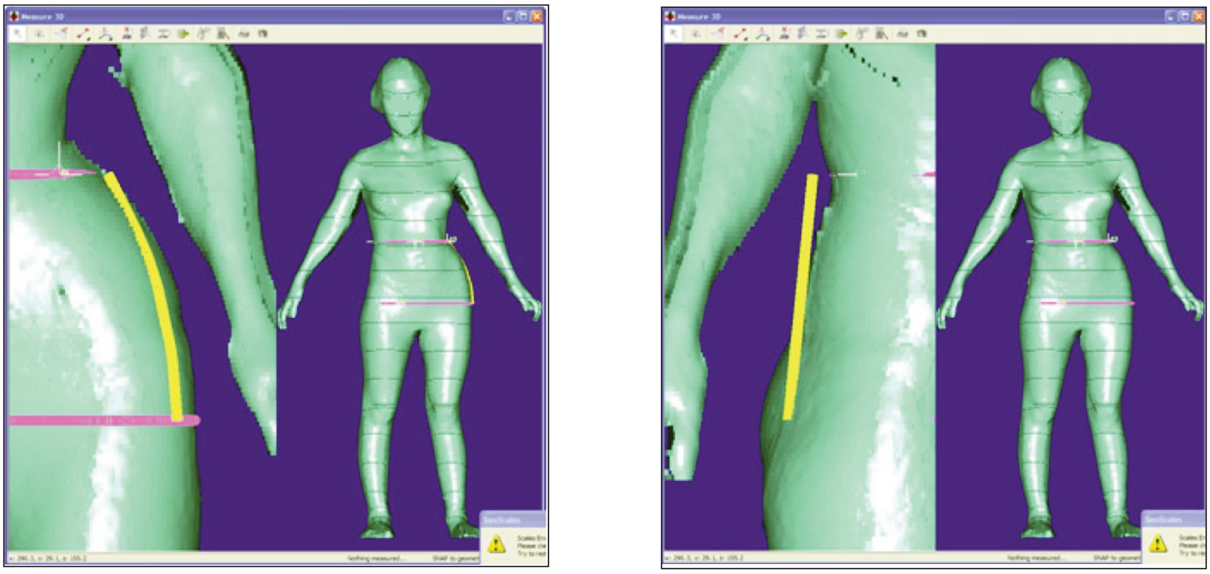


Fig. 6. Shoulder inclination angle



a ***b***

Fig. 7. The hips side length from waist to the buttocks: ***a*** – right; ***b*** – left

Table 8

PERCENTAGE OF STANDARD HEIGHTS FOR BOYS AND GIRLS											
Boys with age 6–19 years											
Body height, cm	122	128	134	140	146	152	158	164	170	176	182
%	4	6	7	7	6	6	7	11	17	19	10
Girls with age 6–19 years											
Body height, cm	122	128	134	140	146	152	158	164	170	-	-
%	4	6	5	5	5	15	28	22	10	-	-

In conclusion:

- It was considered as clothing size the body height, in order to harmonize it with European similar standards;
- Market rates of interest for manufacturers of garments for children are those presented in table 8. Studying the values from table 8, we observe that the highest percentage of 17% and 19% occurs in boys with height of 170 cm and 176 cm, respectively 28% and 22% in girls with a height of 158 cm and 164 cm;
- BMI results show that the percentage of overweight boys in the younger age group is 25,4%, decreasing it with growth, reaching young group to 15,1%; girls in the age group 16–19 years, the percentage of underweight girls is worrying with a value of 19.1% due to the models imposed by the fashion and stylists.

The database created in 2010–2011 offers the possibility of new research approach that will aim the analysis of the human body and human models for children in Romania, the application of anthropometric data in commerce, application of anthropometric data to design medical devices and in health management system.

Further studies involving a multidisciplinary collaborative practice is based on digitized human model as a tool to calculate the size and transform human model design, CAD/CAM, rapid prototyping and engineering applications.

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Effect of caustic soda treatment on some comfort aspects of polyester/cotton workwear fabrics

TANVEER HUSSAIN AFFAN ABID

REZUMAT – ABSTRACT

Efectul tratamentului cu sodă caustică asupra confortului țesăturilor din poliester/bumbac destinate echipamentelor de lucru

Scopul acestui studiu a fost acela de a investiga efectul tratamentului caustic asupra unor aspecte privind confortul țesăturilor de poliester/bumbac destinate echipamentelor de lucru. Mostrele de țesături, impregnate în stare tensionată, cu diferite concentrații de sodă caustică, au fost supuse, anumite intervale de timp, procesului de aburire cu abur saturat. Mostrele spălate, neutralizate şi uscate au fost testate în ceea ce priveşte caracteristicile de confort, iar rezultatele au fost analizate din punct de vedere statistic. S-a constatat că, în urma tratamentului cu sodă caustică, proprietățile termofiziologice şi de confort ale țesăturilor din poliester/bumbac au fost îmbunătățite în mod semnificativ.

Cuvinte-cheie: confort, sodă caustică, alcalii, managementul umidității, echipament de lucru, poliester, bumbac

Effect of caustic soda treatment on some comfort aspects of polyester/cotton workwear fabrics

The aim of this study was to investigate the effect of caustic treatment on some comfort aspects of polyester/cotton blended workwear fabrics. Fabric samples, impregnated in tension state at different caustic soda concentrations, were subjected to steaming in saturated steam for different times. Rinsed, neutralized and dried samples were tested for different comfort properties and the results were statistically analysed. It was found that the caustic treatment significantly improves the tactile as well as thermo-physiological comfort properties of the treated polyester/cotton blended fabrics.

Key-words: comfort, caustic soda, alkali, moisture management, workwear, polyester, cotton

Desirable performance at the workplace, durability and long service life are some of the key characteristics required from the workwear fabrics. In comparison to formal dress shirts, workwear apparels have to bear more taxing conditions not only in wearing but also during laundering. In order to meet these stringent requirements, workwear apparels are often made from a bit heavier fabrics having higher yarn linear densities as well as fabric densities, compared to formal dress shirts. Heavier fabric construction gives better performance properties to workwear but usually at the cost of comfort properties.

Comfort is a fundamental and universal requirement of a human being and may be defined as a state of being free from any physical distress, physiological disturbance or psychological displeasure. Among various aspects of clothing comfort, the most common is the tactile or sensorial comfort which is related with the elicitation of various sensations on the hand or the body skin when it comes into contact with the clothing [1]. Other important aspects of clothing comfort include comfortable thermal and wetness state of the wearer. Comfortable thermal state is related with retention of body heat to a comfortable level in winter and its transmission to the environment in summer through conduction, convection, radiation or evaporation of perspiration [2]. Similarly, a comfortable wetness state involves the engineered movement of human perspiration from the skin, through the clothing to the environment, a phenomenon commonly known as "moisture management" [3–4].

Sensorial or tactile comfort in clothing can be achieved in many ways including the use of special fibers such as micro-polyester, micro-modal and micro-tencel, or using softer yarns with less twist or making fabrics with lower densities and using special finishes. Similarly, better thermal-wet comfort may be attained through use of profiled fibres or specially engineered yarn and fabric structures [5–6]. However, the use of special fibres and specially engineered structures involve higher cost of manufacturing while the use of softer yarns and lower fabric densities may sacrifice the fabric performance.

Polyester/cotton blended fabrics have attained highest popularity among different blends because of good all-round performance and attractive price. Addition of polyester in the blend improves the fabric performance, wrinkle recovery and durability but with a sacrifice of comfort properties of the fabric. Several attempts have been made to enhance the comfort properties of pure polyester fabrics including the caustic treatment with sodium hydroxide [7–10]. Mercerization of 100% cotton fabrics with caustic soda at cold and warm conditions is also a well-known process [11]. Little appears to have been published on the caustic treatment of polyester/cotton blended fabrics. A couple of studies, found in this regard, include the treatment of polyester/cotton blended fabrics at warm conditions (60°C) in slack state [12–13]. No study has been found on the treatment of polyester/cotton blended fabrics with concentrated caustic solutions in hot steaming conditions above 100°C while keeping the fabric in tension state. Furthermore, no studies have been found so far on the effect of caustic treatment of polyester/cotton blended fabrics on the moisture management properties of the treated fabric, measuring the movement of liquid moisture within the fabric in three dimensions. This study is an attempt to fill this gap and endeavours to add a little more knowledge to what is already known in this domain.

EXPERIMENTAL PART

Fabrics used

The fabrics used in this study was industrially desized and bleached polyester/cotton blended workwear fabric with 52% polyester and 48% cotton, 16 Ne warp and weft yarns linear density, 120 ends/inch, 56 picks/inch and 240 g/m^2 weight.

Chemicals used

Commercial grade caustic soda was used for caustic treatment of the samples and commercial grade acetic acid was used for neutralization of the samples after the caustic treatment. For this purpose, have been used: specific machinery and equipment, fabric impregnator, Mathis laboratory steamer, fabric GSM cutter, Sartorius digital weighing balance, Shirley feather touch digital thickness tester, Shirley fabric stiffness tester, fabric air permeability tester, SDL Atlas moisture management tester (MMT).

Treatment of the fabric samples

Polyester/cotton blended fabric samples were impregnated separately in caustic soda solutions at 50, 100, 150, 200, 250 and 300 g/l concentrations in a stainless steel high add-on impregnator specially designed for this study to obtain a wet pick-up of 130%. Before the impregnation, each sample was affixed on a Mathis laboratory steamer frame. The frame containing the sample was impregnated in the caustic soda solution. The purpose of affixing the sample on the frame, before impregnation, was to avoid any shrinkage or dimensional change in the fabric during impregnation in the caustic soda solution. After impregnation, samples of each caustic soda concentration were subjected to steaming in a saturated steam on Mathis laboratory steamer for different times, i. e. 5, 10 and 15 minutes. After steaming, the fabric samples, while still on the frame, were rinsed and neutralized with acetic acid solution until the samples were completely neutralized and there was no caustic soda remaining in the samples. All the treated samples were dried in ambient air, followed by conditioning and testing.

Testing of the fabric samples

Fabric GSM was measured according to ASTM D-3776. Fabric thickness was calculated according to ASTM D-1777. Bending length of the fabric samples was measured according to ASTM D-1388 and the flexural rigidity [14] was calculated by using the following equation (1):

$$\textit{Flexural rigidity} = (1/8) \times W \times L^3 \qquad (1)$$

where:

W is the fabric weight, in g/cm^{-2};

L – the average bending length, in cm.

The overall fabric porosity [15] was calculated according to the following equation (2):

$$\textit{Porosity} = 1 - (\rho_b/\rho_s) \qquad (2)$$

where:

ρ_b is the fabric density, in g/cm^{-3};

ρ_s – the fibre density, in g/cm^{-3}.

Fabric air permeability was measured according to ISO 9237:1995. Liquid moisture management properties of the fabric samples were tested using SDL Atlas moisture management tester according to AATCC TM 195-09.

RESULTS AND DISCUSSIONS

A summary of the results depicting the effect of caustic treatment on physical properties of the treated P/C blended fabrics is given in table 1. The results were analysed statistically using MINITAB® statistical software and the findings are summarized in table 2. It was found that both the concentration of caustic soda and the treatment time have significant effect (p-values 0.000) on fabric weight loss. This may be attributed to hydrolysis of the polyester component in the blend in the presence of caustic soda. It was further found that there is a significant interaction between NaOH concentration and the treatment time. This is evident in figure 1*a*, which shows that the effect of increasing the treatment time is more prominent at higher caustic concentrations, and the effect of increasing caustic concentration is more prominent with higher treatment time. Figure 1*b* shows that the caustic treatment also results in decrease in fabric thickness but the decrease is not as much evident as is the weight loss. This may be attributed to the fact that while caustic treatment causes hydrolysis of the polyester fibres, it also results in the some swelling of cotton fibres at the same time.

Fabric weight loss and decrease in thickness results in decrease in bending length and flexural rigidity of the fabric as shown in figure 2*a* and figure 2*b*. Decrease in flexural rigidity of the fabric implies enhanced tactile comfort of the fabric. Fabric weight loss due to hydrolysis of the polyester fibres also results in increase in the fabric porosity and increase in fabric air permeability, as depicted in figure 3*a* and figure 3*b*. This increase in fabric air permeability entails higher fabric breathability and thermo-physiological comfort in hot weather and/or during strenuous activity of the wearer. Hence, the caustic treat-

Table 1

EFFECT OF CAUSTIC TREATMENT ON PHYSICAL PROPERTIES OF POLYESTER/COTTON BLENDED FABRICS							
NaOH, g/l	**Time**, min.	**Weight loss**, %	**Thickness**, mm	**Bending length**, cm	**Flexural rigidity**, g/cm	**Porosity**	**Air permeability**, mm/s.
50	5	3.2	0.52	2.35	0.038	0.69	61
50	10	3.6	0.53	2.38	0.040	0.69	61
50	15	3.6	0.53	2.34	0.038	0.69	63
100	5	2.3	0.53	2.44	0.043	0.69	67
100	10	4.1	0.52	2.38	0.039	0.69	70
100	15	7.0	0.51	2.30	0.034	0.70	67
150	5	4.9	0.50	2.36	0.038	0.68	72
150	10	8.1	0.52	2.22	0.031	0.70	76
150	15	11.2	0.51	2.09	0.024	0.71	98
200	5	4.3	0.52	2.37	0.039	0.69	95
200	10	10.3	0.51	2.11	0.026	0.70	78
200	15	13.5	0.52	2.10	0.024	0.72	118
250	5	4.0	0.53	2.37	0.039	0.70	98
250	10	12.5	0.50	2.33	0.034	0.71	108
250	15	15.5	0.51	2.02	0.021	0.72	102
300	5	4.1	0.51	2.18	0.030	0.69	105
300	10	15.0	0.51	2.26	0.030	0.72	128
300	15	19.0	0.49	2.09	0.022	0.72	128

Table 2

STATISTICAL ANALYSIS OF EFFECT OF CAUSTIC TREATMENT ON PHYSICAL PROPERTIES OF POLYESTER/COTTON BLENDED FABRICS						
Terms	***p* - values**					
	Weight loss, %	**Thickness**, mm	**Bending length**, cm	**Flexural rigidity**, g/cm	**Porosity**	**Air permeability**, mm/s.
NaOH, g/l	0.000*	0.036*	0.007*	0.001*	0.000*	0.000*
Time, min.	0.000*	0.216	0.003*	0.000*	0.000*	0.035*
NaOH * NaOH	0.510	1.000	0.439	0.431	0.762	0.651
Time * Time	0.039*	0.752	0.478	0.778	0.278	0.585
NaOH * Time	0.000*	0.140	0.325	0.173	0.008*	0.330
	R-Sq 97.03%	R-Sq 45.17%	R-Sq 69.07%	R-Sq 79.23%	R-Sq 88.28%	R-Sq 88.00%

* statistically significant at 95% confidence level;
** statistically significant at 90% confidence level.

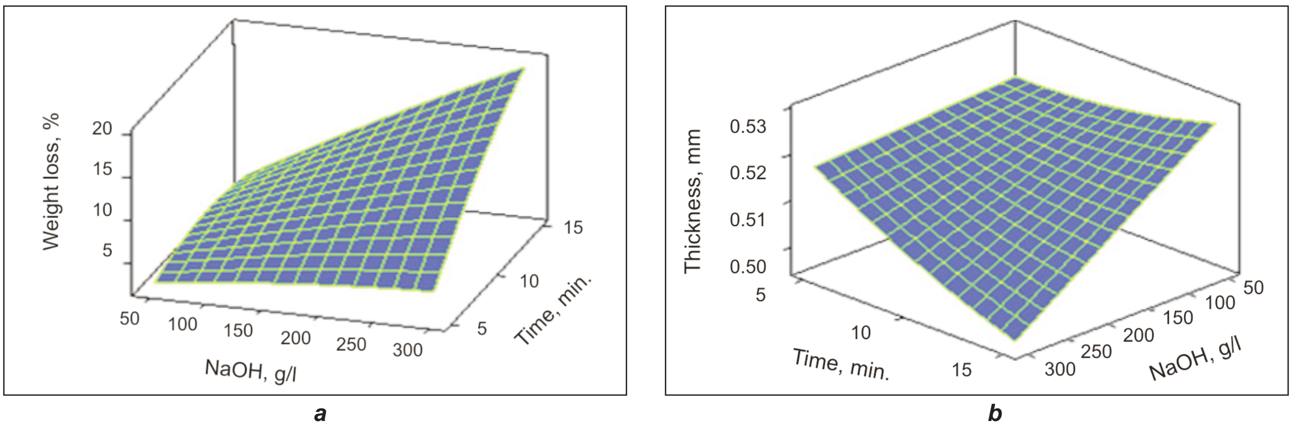


Fig. 1. Effect of NaOH concentration and time on:
a – fabric weight loss; ***b*** – fabric thickness

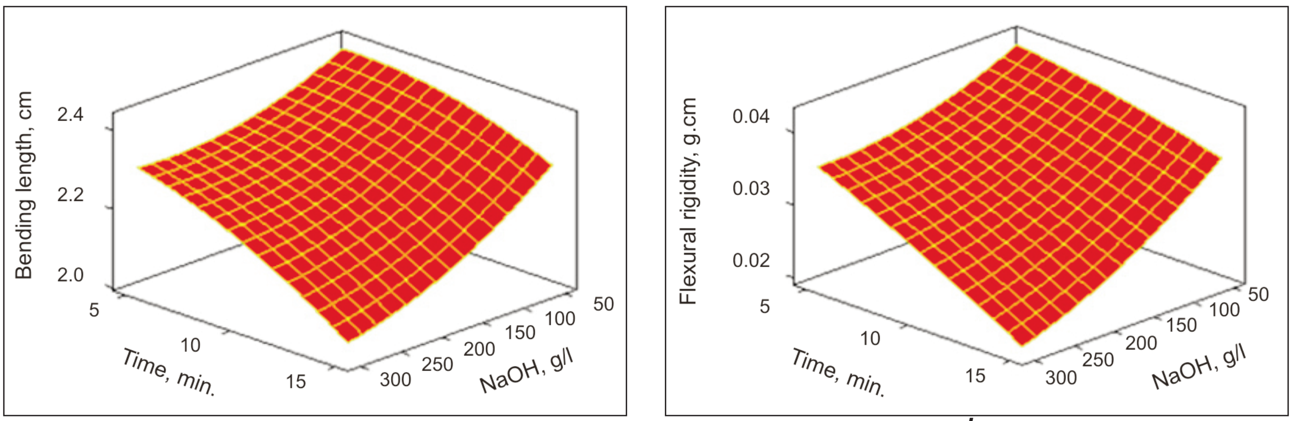
Table 3

EFFECT OF CAUSTIC TREATMENT ON MOISTURE MANAGEMENT PROPERTIES OF POLYESTER/COTTON BLENDED FABRICS											
NaOH, g/l	Time, min.	WT_T, s.	WT_B, s.	AR_T, %/s.	AR_B, %/s.	MWR_T, mm	MWR_B, mm	SS_T, mm/s.	SS_B, mm/s.	*R*	*OMMC*
50	5	2.98	3.57	53.51	36.75	23	24	5.00	3.89	456.33	0.81
50	10	3.32	3.88	51.13	36.69	25	25	5.07	3.75	470.60	0.80
50	15	2.83	3.56	54.20	35.11	25	20	5.14	3.63	458.15	0.79
100	5	3.11	3.31	53.74	33.69	23	24	5.12	5.31	379.23	0.79
100	10	3.07	3.16	54.63	54.24	25	25	5.50	5.32	288.53	0.75
100	15	3.03	3.03	54.18	53.34	25	25	5.53	5.33	261.20	0.72
150	5	2.93	3.06	54.75	40.83	25	25	5.50	4.56	485.48	0.84
150	10	2.95	2.93	55.75	56.56	25	25	5.48	5.52	236.99	0.70
150	15	2.95	2.83	55.70	56.45	25	25	5.72	5.66	233.46	0.69
200	5	2.75	2.99	54.00	58.85	25	26	5.68	5.56	244.73	0.71
200	10	2.82	2.87	56.33	40.82	25	25	5.68	5.05	462.95	0.84
200	15	2.75	2.71	51.82	47.24	25	25	5.57	5.32	392.91	0.81
250	5	2.72	2.85	56.21	41.90	26	25	5.63	4.91	498.06	0.84
250	10	2.82	2.79	56.03	42.06	25	25	5.77	5.12	518.01	0.84
250	15	2.71	2.79	51.50	56.88	26	25	5.94	5.77	239.55	0.70
300	5	2.85	3.14	51.94	40.00	25	25	5.68	4.85	466.62	0.83
300	10	2.75	2.87	51.62	39.82	25	25	5.58	5.15	456.16	0.83
300	15	2.85	2.91	55.25	36.53	25	25	5.64	5.60	324.61	0.74
Untreated		3.15	3.34	60.12	37.50	20	25	4.79	5.26	426.63	0.82

Table 4

STATISTICAL ANALYSIS OF EFFECT OF CAUSTIC TREATMENT ON MOISTURE MANAGEMENT PROPERTIES OF POLYESTER/COTTON BLENDED FABRICS										
Terms	***p* - value**									
	WT_T, s.	WT_B, s.	AR_T, %/s.	AR_B, %/s.	MWR_T, mm	MWR_B, mm	SS_T, mm/s.	SS_B, mm/s.	*R*	*OMMC*
NaOH, g/l	0.002*	0.000*	0.982	0.780	0.019*	0.037*	0.000*	0.004*	0.767	0.504
Time, min.	0.616	0.010*	0.819	0.218	0.063**	0.271	0.030*	0.155	0.096**	0.065**
NaOH * NaOH	0.353	0.000*	0.105	0.010*	0.285	0.060**	0.001*	0.004*	0.106	0.231
Time * Time	0.182	0.743	0.712	0.951	0.565	0.337	0.998	0.832	0.488	0.455
NaOH * Time	0.542	0.719	0.808	0.577	0.033*	0.201	0.252	0.232	0.540	0.629
	R-Sq 62.06%	R-Sq 92.47%	R-Sq 21.72%	R-Sq 48.77%	R-Sq 61.10%	R-Sq 53.80%	R-Sq 87.84%	R-Sq 70.80%	R-Sq 37.89%	R-Sq 36.96%

* statistically significant at 95% confidence level;
** statistically significant at 90% confidence level.



a *b*

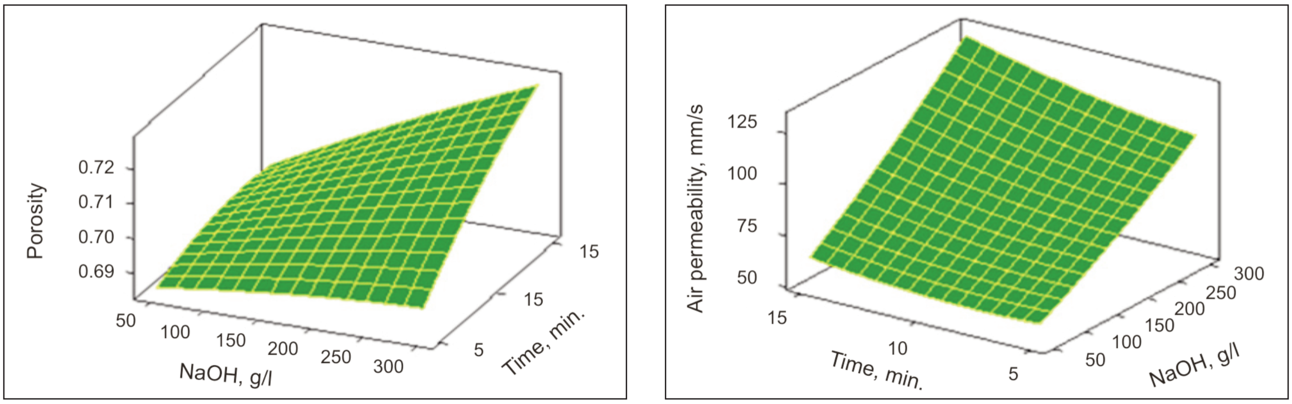
Fig. 2. Effect of NaOH concentration and time on:
a – fabric bending length; ***b*** – flexural rigidity

ment of the P/C blended fabrics not only makes them more pliable and pleasing to touch but also more breathable and physiologically comfortable to wear.

A summary of the mean values of the results depicting the effect of caustic treatment on moisture management properties of the treated polyester/cotton blended fabrics is given in table 3. The results of the statistical analysis of the same are summarized in table 4. It was found that the fabric wetting time, both at the top, WT_T and bottom fabric side, WT_B, is significantly reduced by the caustic treatment (fig. 4). Wetting time is the time in seconds when the top and bottom surfaces of the fabric begin to be wetted after a measured drop of test-water falls on the fabric. Top fabric surface refers to that side of the fabric with which the test-water drop first comes in contact. It represents that side of the fabric which would come in contact with the skin of the wearer, and which will first encounter the perspiration. The reduction in wetting time because of caustic treatment may be attributed to an increase in the surface energy of the polyester fibre due to partial hydrolysis, and increase is surface area of the cotton fibres due to swelling.

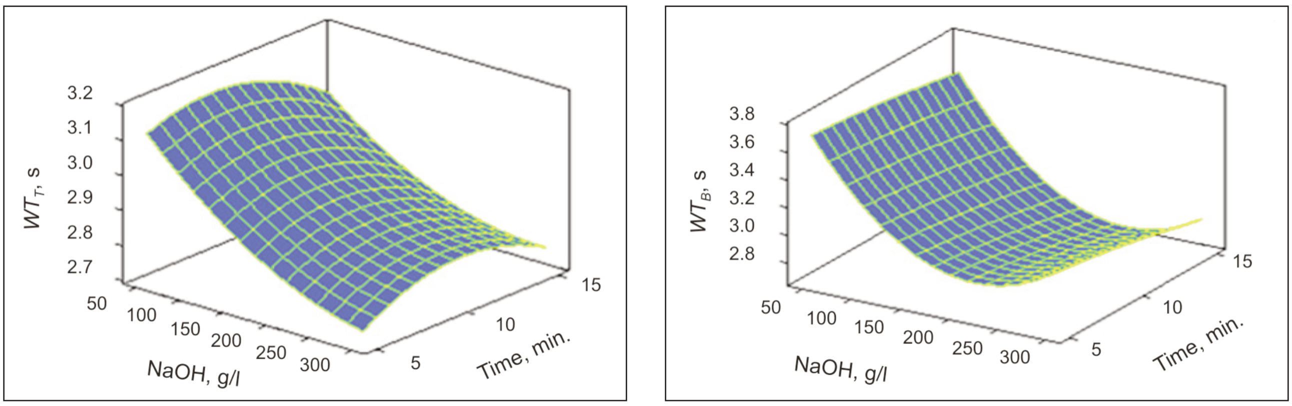
Although water absorption rate at the top fabric surface, AR_T, was not significantly affected by the treatment, it was significantly affected at the bottom side of the fabric, AR_B. Absorption rate is the average speed at which the test-water is absorbed by the fabric during the initial change of water content of the fabric during the test. A significant increase in the absorption rate at the bottom fabric surface may be due to quicker arrival of the water at the bottom because of decrease in fabric thickness after the caustic treatment.

The spreading of water on the fabric, both in terms of speed as well as maximum wetted radius, was also found to be significantly increased after the caustic treatment (fig. 5 and fig. 6). Spreading speed is the accumulated rate of wetting of top, SS_T, and bottom, SS_B, fabric surfaces from the centre of the test specimen where the test-water is dropped to the respective maximum wetted radii, MWR_T & MWR_B. This may be attributed to increase in wickability of the fabric due in increase in its porosity after of the caustic treatment. Accumulative one-way transport capability, R, of the fabric to transmit the water from the top to the bottom fabric side was also found to be significantly affected (with 90% confidence level) by the caustic treatment. This may be due to decrease in fabric thickness as well as increase in fabric porosity after the treatment. Similarly, overall moisture



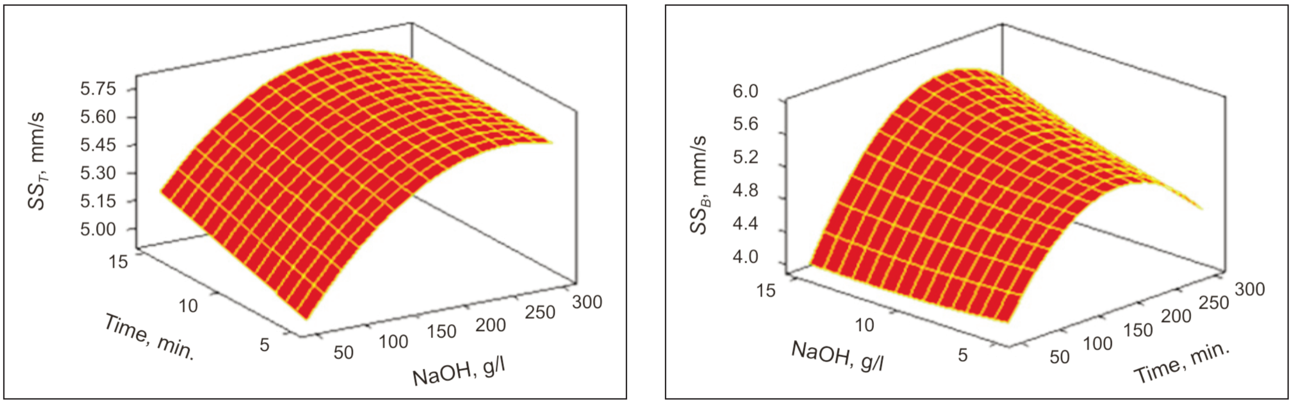
a *b*

Fig. 3. Effect of NaOH concentration and time on:
a – fabric porosity; ***b*** – air permeability



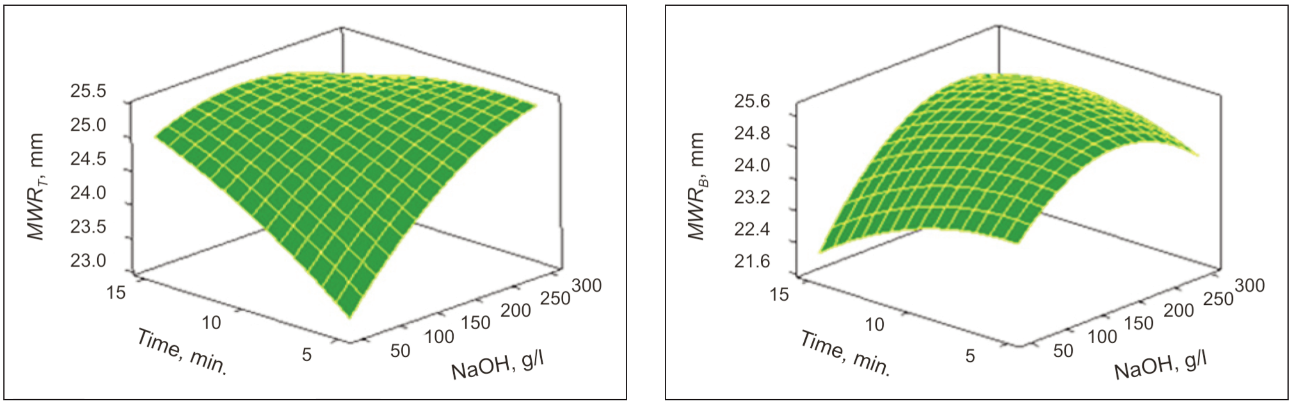
a *b*

Fig. 4. Effect of NaOH concentration and time on:
a – WT_T; ***b*** – WT_B



a *b*

Fig. 5. Effect of NaOH concentration and time on:
a – SS_T; ***b*** – SS_B



a *b*

Fig. 6. Effect of NaOH concentration and time on:
a – MWR_T; ***b*** – MWR_B

management capability, *OMMC*, of the fabric was also found to be significantly enhanced (90% confidence level) by the caustic treatment. The *OMMC* is the overall capability of the fabric to transport moisture along the three dimensions of the fabric, and is calculated by combining three attributes: moisture absorption rate on the bottom fabric surface, AR_B, spreading speed on the bottom fabric surface, SS_B, and accumulative one-way transport capability, *R*.

CONCLUSIONS

Caustic treatment of polyester/cotton blended workwear fabrics not only improves the tactile comfort of the treated fabrics but also their liquid moisture management properties. With decrease in denier of the polyester fibre and the resulting decrease in fabric thickness, the flexural rigidity of the fabric decreases and the fabric becomes less stiff and more pliable. With increase in fabric porosity, the air permeability and liquid moisture transport in the three dimensions of the fabric is also increased. As a result, moisture management properties of the treated fabric are enhanced. It can be concluded from the results that the caustic treatment of polyester/cotton blended fabrics improves the tactile as well as thermo-physiological comfort properties of the treated fabrics.

Acknowledgement

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DOCUMENTARE

Materii prime

FIBRE TENCEL SKIN PENTRU MĂŞTILE DE ÎNGRIJIRE A FEŢEI

Lenzing a dezvoltat o fibră specială, *Tencel Skin*, pentru substraturi neţesute netede, destinate producerii măştilor de îngrijire a feţei, care a fost lansată la Conferinţa şi Expoziţia de Neţesute din Asia (ANEX), desfăşurată la Seoul, Coreea de Sud, în perioada 13–15 iunie 2012.
Compania austriacă Lenzing AG consideră că fibra Tencel Skin a fost creată pentru a satisface nevoile estetice ale milioanelor de bărbaţi şi femei din Asia, care utilizează deja astfel de măşti.
În plus, tendinţa de utilizare a unor astfel de produse de îngrijire a feţei s-a extins în prezent şi în S.U.A. şi Europa, cu branduri internaţionale de renume, care deţin portofolii extinse.
Substratul neţesut este componenta-cheie a acestor măşti, iar fibrele de celuloză Tencel Skin au un nivel ridicat de puritate. În plus, structura lor fibrilară la scară nano este potrivită pentru aplicarea oricărei loţiuni utilizate în măştile de îngrijire a feţei. Elisabeth Stanger, directorul de marketing al Unităţii de Neţesute, afirmă că suprafaţa netedă şi fină, obţinută în urma folosirii acestei fibre, asigură utilizatorilor un confort de neegalat.
În cadrul Expozitiei ANEX, Lenzing a subliniat faptul că fibrele celulozice folosite sunt pure şi biodegradabile. Ele sunt realizate din materii prime regenerabile, cum ar fi lemnul provenit din păduri atent administrate.
Kosé – una dintre cele mai mari companii de cosmetice din Tokyo, care produce măşti de îngrijire a feţei, utilizează fibra Tencel pentru gama de produse *Cosmeport Clear Turn*.

Sursa: www.lenzing.com

One-bath dyeing of polyester/cotton blend with reactive dye after alkali and chitosan treatment

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PETAR JOVANČIĆ
IVANKA RISTIĆ
DRAGAN JOCIĆ

REZUMAT – ABSTRACT

Vopsirea într-o singură baie a amestecurilor din poliester/bumbac cu coloranți reactivi, după tratamentul cu alcalii şi chitosan

În lucrare s-a studiat efectul tratamentului cu alcalii şi chitosan asupra caracteristicilor de vopsire reactivă a amestecurilor din poliester/bumbac. Au fost utilizate diferite metode de caracterizare a modificărilor fizice şi chimice în stratul de suprafață al fibrei de poliester şi utilizarea colorantului, după aplicarea unor tratamente individuale şi combinate. Vopsirea simultană a țesăturilor din bumbac şi poliester şi a amestecurilor din poliester/bumbac au fost efectuate în urma aplicării unor tratamente individuale şi hibride. Țesăturile vopsite au fost evaluate în funcție de intensitatea şi rezistența culorii. Prin aplicarea unui tratament alcalin, suprafața fibrei de poliester s-a modificat din punct de vedere fizic şi chimic şi, în acelaşi timp, bumbacul mercerizat a favorizat absorbția colorantului reactiv C.I. Reactive Red 3 şi creşterea intensității vopsirii cu 24%, în cazul țesăturii din amestec de fibre. Prin depunerea biopolimerului de chitosan, intensitatea vopsirii pe toate mostrele a crescut proporțional cu concentrația, în special în cazul poliesterului. Tratamentul hibrid, care combină tratamentele cu alcalii şi chitosan, s-a dovedit a fi cel mai eficient şi ar putea permite o nouă abordare a vopsirii şi finisării textile.

Cuvinte-cheie: amestec, vopsire, colorant reactiv, tratament cu alcalii, chitosan, strat de suprafață, tratament hibrid, intensitatea vopsirii

One-bath dyeing of polyester/cotton blend with reactive dye after alkali and chitosan treatment

The effect of alkali and chitosan treatment on reactive dyeing characteristics of polyester/cotton blend is studied in this work. Various methods for characterization of physical and chemical changes in the surface layer of polyester fiber and dye utilization after individual and combine treatments were used. A simultaneous dyeing of cotton and polyester fabrics and dyeing of factory blends of polyester/cotton were carried out after individual and hybrid treatment. Dyed fabrics were evaluated by dye intensity and fastness. By using alkali treatment, the surface of polyester fiber is physically and chemically modified and at the same time the cotton is mercerized, favorably affecting absorption of reactive dye C.I. Reactive Red 3, resulting to a dye intensity increase of 24% on factory blend. With deposition of chitosan biopolymer, dye intensity on all samples is increased proportionally with concentration, especially on polyester. Hybrid treatment combining alkali and chitosan treatments is the most effective and it could enable a new approach to textile dyeing and finishing.

Key-words: blend, dyeing, reactive dye, alkali treatment, chitosan, surface layer, hybrid treatment, dye intensity

Blends of polyester and cotton are the most popular blends in clothing industry due to complementary properties of these fibers [1]. Easy care polyester and cotton blend is used for making fabrics for man's and woman's clothing, shirts, sport garments, uniforms, coats, bedding and table cloths. According to literature, 90% of work clothing is made of polyester/cotton blends because these fabrics are considerably more stabile to washing, i.e. they resist three times more washing cycles compared to cotton fabrics [2]. In polyester/cotton blends, polyester is characterized by high strength, possibility of thermal stabilization, excellent care behavior, uniform quality but it also has some disadvantages in terms of low water adsorption, static electricity, high tendency for contamination with oil impurities etc. The nature component – cotton, is characterized by high ability for water adsorption and release, in that way it offers indispensable comfort to textile, but it has lower mechanical properties than synthetic fibers. In polyester and cotton blends, combination of their properties gives improved overall quality of material.

The current known dyeing methods for binary textile blends polyester/natural fiber use two classes of dyes for dyeing of components in one or two solutions, producing high quantities of polluted waste waters embarrassing the whole environment. The global initiative for rational utilization of natural resources and increasingly more stringent environmental legislation impose the need for development of new methods more superior compared to traditional dyeing in terms of technological productivity, economy and protection of watercourses. Moreover, the new dyeing methods should provide high performances of dyes on textile, and from this point of view the main challenge in dyeing of blends is matching color intensities on blend components. In order to rationalize dyeing of polyester/cotton blends, recently, dyes with new coloristic properties have been developed or pretreatments improving dye affinity for fibers have been applied [3–8].

In this work, commercial polyester, cotton and factory blended polyester/cotton fabrics were treated with alkali and chitosan solutions of various concentrations, with the aim to improve dyeing with reactive dye. The effects of alkali on surface structure and chemical composition of polyester have been studied. The improved dyeing of components and factory blended polyester/cotton blends after combined pretreatment was evaluated by color intensity, fixation degree and dye fastness.

EXPERIMENTAL PART

Material and methods

100% polyester commercial fabric with surface mass of 149,5 g/m^2, 100% cotton fabric with surface mass of 206,67 g/m^2 and 50/50% polyester/cotton factory blend with surface mass of 172,53 g/m^2 were used in experiments.

Alkali treatment of polyester fabrics (separately and in combination with cotton fabrics) and fabrics of blended composition was performed in aqueous NaOH solution (Kemika – Croatia) in Ahiba apparatus (Type G7B) with vertical material movement in closed metal cuvettes at temperatures of 80 and 100ºC, alkali concentrations were 15, 50 and 80 g/dm^3 and treatment time 20, 40, 60, 75 and 90 minutes. Sample mass was 5 g and solution volume was 200 cm^3. After alkalization the samples were neutralized with diluted acetic acid followed by distilled water rinsing and drying in air.

Mass loss (*GM*) of alkali treated polyester fabrics was estimated using equation (1):

$$GM = \frac{m_1 - m_2}{m_1} \times 100 \quad [\%] \qquad (1)$$

where:

m_1 is mass of untreated sample;

m_2 – mass of hydrolyzed sample; sample mass was weighed on analytical balance with accuracy of 0,0001 g.

Chitosan used for treatments was obtained from Primex – Norway and it has the following characteristics: degree of deacetylation 96%, viscosity 102 cP, solubility 99.9%, dry matter content 85% and ash content 0.1%. Chitosan was used without further purification. Chitosan treatment was performed in freshly prepared solutions with concentrations of 1, 5 and 10 g/dm^3. Liquor ratio in chitosan treatment was 1:20, treatment temperature 25ºC for 20 minutes with continuous stirring. After treatment the samples were sqeezed on padder at the same conditions and dryed in air at ambient temperature, washed with distilled water and dryed again.

Reactive dye C.I. Reactive Red 3, molecular mass 774,048 g/mol (Bayer – Germany), was used for dyeing of pretreated samples and its structure is shown in figure1. The dye was commercial quality.

To characterize surface morphological changes on polyester surface scanning electron microscope JEOL JCM 5300 (Jeol – Japan) was used. The samples were prepared by standard preparation technique of gold sputtering producing conductive surface on a cathode gold sputter for 5 minutes.

The content of end carboxyl groups is in direct correlation with static ion-exchange capacity (*SJK*), that is determined by volumetric method as follows: in an Erlenmeyer flask containing 100 cm^3 of 0.01M NaOH solution 0,1 g of fiber is added (weighed to 0,0001 g). The flask is stopped to prevent reaction between NaOH and CO_2 from air. Treatment is performed for 1 hour with stirring and than 20 cm^3 of the solution is taken and titrated with 0.01 M HCl solution with phenolphthalein indicator. Three measurements are made and an average of acid volume used is taken. *SJK* is calculated as follows [9]:

$$SJK = 5\,\frac{V_{NaOH} \cdot c_{NaOH} - V_{HCl} \cdot c_{HCl}}{m(1 - w)} \ [\text{mmol/g}] \qquad (2)$$

where:

V_{NaOH} is NaOH volume taken for titration, cm^3;

V_{HCl} – HCl volume used up for titration, cm^3;

c_{NaOH} – molar concentration of NaOH solution, mol/dm^3;

c_{HCl} – molar concentration of HCl solution, mol/dm^3;

m – fiber mass, g;

w – moisture content, %.

Based on the values obtained and the ratio of COOH group concentrations for alkalized and untreated sample, relative increase of carboxyl group content of modified polyester fabrics compared to untreated fabrics was estimated.

In the experiment, pretreated polyester and cotton fabric samples and factory blend of polyester/cotton 50/50 were simultaneously dyed. In simultaneous dyeing, mass ratio of components was 50:50. Sample mass was 4 g and liquor ratio 1:45.

Dyeing was carried in laboratory dyeing apparatus Ahiba type G7B (Ahiba, Swiss) with vertical movement of material as shown on diagram in figure 2.

After dyeing fabrics were rinsed with hot and cold distilled water. After dye values were measured, samples dyed with reactive dye were treated in soap

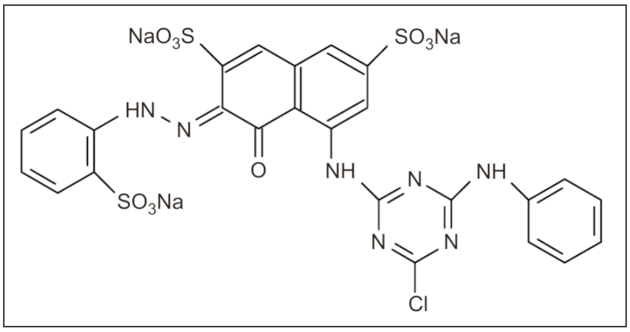

Fig. 1. Dye structure of C.I. Reactive Red 3 (RR 3), C.I. 18159

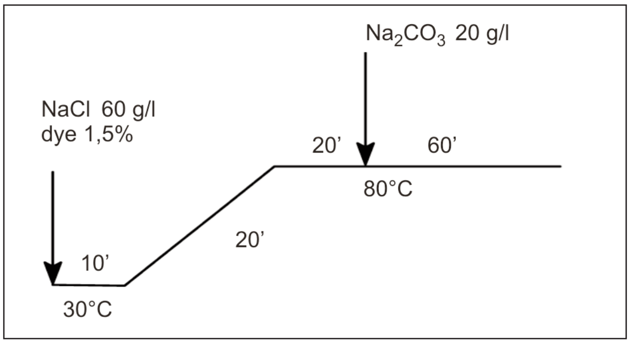

Fig. 2. Dyeing diagram with C.I. Reactive Red 3

Color reflaxion values and color coordinates were determined with reflexion spektrophotometer Spectraflash SF600X (Datacolor) by typical procedure. After treatment of reactive dyed samples in soap solution (95ºC for 10 minutes) measurement was repeated to estimate dye fixation degree *F*.

Color intensity (*K/S*) was estimated at maximum absorption wavelength (λ = 550 nm) according to Kubelka-Munk equation (3):

$$\frac{K}{S} = \frac{(1-R)^2}{2R} \quad (3)$$

Fixation degree was calculated according to equation (4):

$$F = \frac{\left(\frac{K}{S}\right)_T}{\left(\frac{K}{S}\right)_0} \cdot 100 \quad (4)$$

where:

subscript *T* refers to soap treated fabric and subscript 0 to untreated fabric.

Percentage of color intensity increase (*I*) on modified samples in relation to original sample was estimated from the following equation (5):

$$I = \frac{(K/S)_m - (K/S)_0}{(K/S)_0} \cdot 100 \quad [\%] \quad (5)$$

where:

subscript *m* refers to modified fabric samples and subscript 0 to untreated samples.

Dye fastness to laundering and rubbing for dyed samples was estimated according to ISO 105-C06: 1994 and ISO 105-X12:2001, respectively.

RESULTS AND DISCUSSIONS

Kinetics of mass loss

Chemical constitution and fiber surface morphology play an important role in wet processing of textile material. Low content of polyester carboxyl groups give rise to obvious hydrophobic polyester fiber surface and therefore it is inert to dyes dissociating in dyeing bath. Hydrophilization of polyester, introducing polar oxygen groups into macromolecular structure, can alter polyester behavior, i.e. enable dyeing at 100ºC and possibly using dyes with low thermal stability, e.g. reactive dyes. Alkaline treatment of polyester fabrics has favorable effects on some textile characteristics of practical importance, because fabrics have better aesthetic appearance, they are less prone to pilling, have higher resistance to staining and better hydrophilic properties [10, 11]. Effects observed with alkaline treatment of polyester are highly dependent on mass loss.

Figures 3 and 4, for temperatures 80 and 100ºC, respectively, show graphic presentation of fabric mass loss versus time and NaOH concentration. Prolonged reaction time progressively increases mass loss at higher NaOH concentration and solution temperature. In all cases mass loss with time is linear and is in good agreement with straight line equations shown in table 1.

When polyester is treated in aqueous alkaline solution it loses mass due to nucleophilic substitution in such a way that hydroxyl ions attack electron deficient carbon atoms in carbonyl groups inducing ester group hydrolysis (fig. 5). Alkaline hydrolysis of polymers produces water soluble depolymerized polyester fragments that separate from fiber surface and

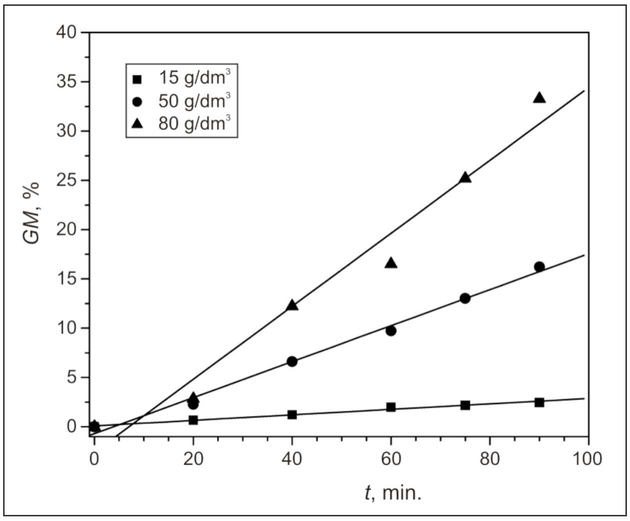

Fig. 3. Mass loss of polyester fabric at 80°C depending on the NaOH concentration

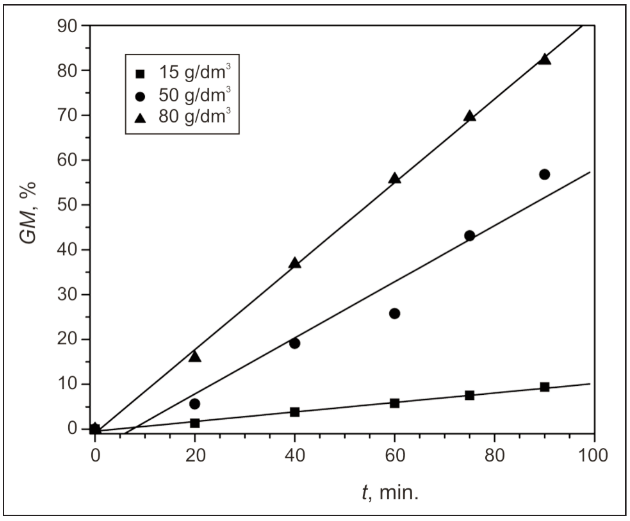

Fig. 4. Mass loss of polyester fabric at 100°C depending on the NaOH concentratione

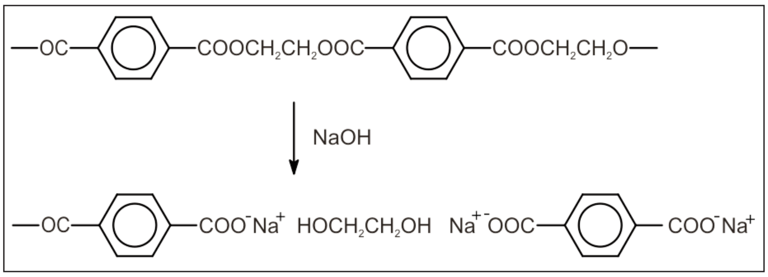

Fig. 5. Scheme of polyester alkali degradation

Table 1

LINEAR EQUATIONS OF MASS LOSS DEPENDING ON TIME AND CORRELATION COEFFICIENTS			
Tempe-rature, °C	**NaOH con-centration,** g/dm^3	**Equation**	***R***
80	15	*GM* = 0.028 · *t* + 0.087	0.992
	50	*GM* = 0.183 · *t* – 0.699	0.996
	80	*GM* = 0.370 · *t* – 2.585	0.984
100	15	*GM* = 0.106 · *t* – 0.415	0.996
	50	*GM* = 0.626 · *t* – 4.671	0.977
	80	*GM* = 0.932 · *t* – 0.894	0.999

Note: *R* is correlation coefficient, *t* – treatment time

transfer to solution, which is observed as a mass loss. Higher mass loss at higher temperatures is explained by increased alkaline diffusion in polyester fiber and is particularly pronounced at temperatures higher than polyester glass transition temperature.

Effect of alkaline treatment on the structure of polyester fiber surface

Fiber surface photographs using SEM reveal very significant differences in surface appearance between untreated samples and samples treated in NaOH solution with various intensities. Untreated fiber has a smooth surface with a number of visible white particles (fig. 6). These particles are oligomers that migrated and crystallized on the surface during stretching and thermal processing. At moderate levels of hydrolysis, rifts and ellipsoidal pits (fig. 7) appear on fiber surface and enlarge with further mass loss (fig. 8). Based on fiber surface morphology changes it could be concluded that reaction of polyester with alkali starts on fiber surface where high negative charge [12] of fiber acts as a barrier hindering penetration of hydroxyl ions to fiber core. Shorter chains, produced as a result of hydrolysis, are removed into solution resulting in mass loss and changes of surface structure. It is, therefore, presumable that polymer degradation occurs on areas of decreased structure order where polymer density and energy of side bonds are lower facilitating access of alkali.

The content of end carboxyl groups

During the treatment of polyester in alkaline solution, modified compounds with terminating carboxyl or hydroxyl groups remain in polyester structure after removal of the products of hydrolytic degradation.
Table 2 shows relative increase of terminating carboxyl groups in alkali treated samples compared to

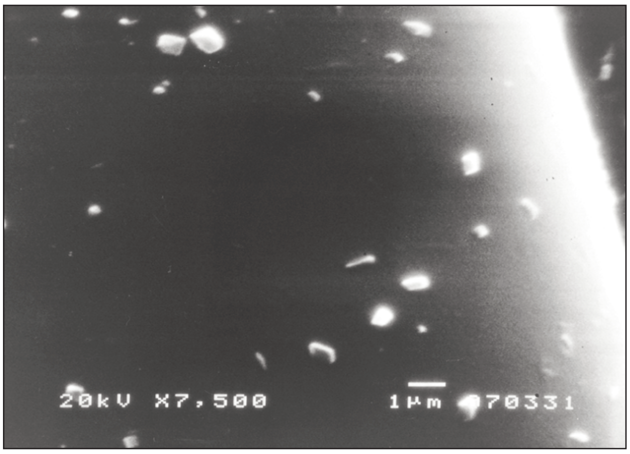

Fig. 6. Scanning micrograph of untreated polyester

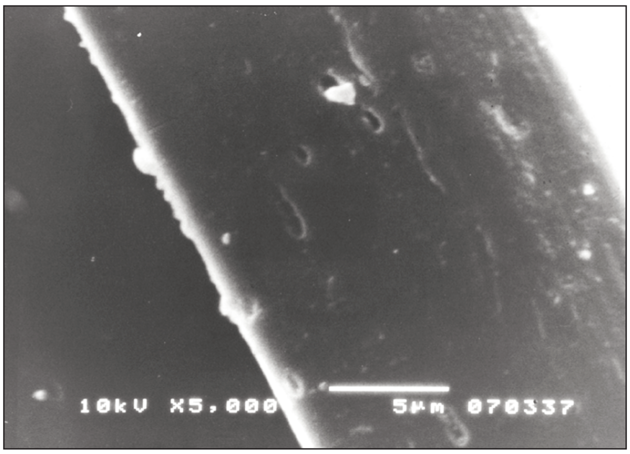

Fig. 7. Scanning micrograph of alkalized polyester *GM* = 6,62%

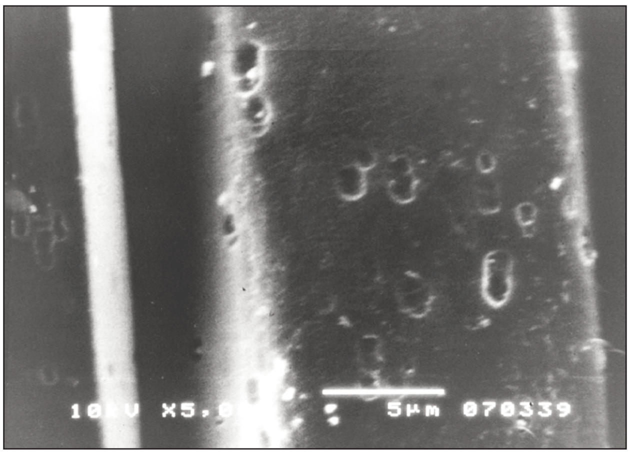

Fig. 8. Scanning micrograph of alkalized polyester *GM* = 13,01%

Table 2

RELATIVE INCREASE OF COOH GROUP NUMBER FOR ALKALI HYDROLYZED POLYESTER FABRICS			
Index of COOH group	**Mass loss, %**	**Sample designation**	**Treatment conditions**
1	-	*R**	utreated
1.85	0.66	*A*	80°C, 20 minutes, 15 g/dm^3 NaOH
2.13	1.98	*B*	80°C, 60 minutes, 15 g/dm^3 NaOH
2.03	2.45	*C*	80°C, 90 minutes, 15 g/dm^3 NaOH
2.26	6.62	*D*	80°C, 40 minutes, 50 g/dm^3 NaOH
2.61	9.74	*E*	80°C, 60 minutes, 50 g/dm^3 NaOH
3.01	16.23	*F*	80°C, 60 minutes, 80 g/dm^3 NaOH

* *R* is referent (untreated) sample

the original sample. The relative increase is 1,85–3 times higher, because it is not possible to establish a simple relation between the number of terminal carboxyl groups and mass loss, i.e. higher mass loss does not necessarily mean higher number of terminal groups. In view of the fact that the mass loss occurs when hydrolysis takes place at the ends of molecules, and that the number of terminal groups increases when hydrolysis takes place inside the polyester macromolecule, it can be concluded that polyester hydrolysis is a statistically random process for defined reaction conditions, which is in accordance with FTIR analysis results of C. Samon et al. [13]. Polyester modified in this way can react through its new functional oxygen groups with various substances, and in that aspect it is similar to natural fibers.

One-bath dyeing of alkali treated polyester/cotton blend with reactive dye

Polyester and cotton fabrics were dyed simultaneously after alkaline treatment in C.I. Reactive Red 3 reactive dye solution. Under the same conditions, factory polyester/cotton blend was also dyed after alkaline treatment.

Dyeing was performed with a selection of samples where technologically significant mass loss of polyester fabrics was obtained in the production of light polyester fabrics with characteristics similar to silk. Reactive dyes are the most important group of dyes for cellulose fibers and their ability of chemical reaction with fibers makes them different from other dye classes. The importance of using one dye class for dyeing cotton-polyester fabrics having ability to be fixed by covalent bond refers also to the possibility of synthesis and use of reactive disperse dyes and, in recent times, disperse dyes containing a reactive group [14].

Table 3

SIMULTANEOUS DYEING RESULTS OF POLYESTER, COTTON AND FACTORY BLEND SAMPLES PRETREATED WITH ALKALI SOLUTION		
Sample	***K/S***	***I*, %**
R polyester	0.028	-
A polyester	0.046	64.3
B polyester	0.048	71.4
C polyester	0.047	67.8
D polyester	0.050	78.6
E polyester	0.056	100
F polyester	0.068	142.8
R cotton	2.81	-
A cotton	3.61	28.5
B cotton	3.45	22.8
C cotton	3.23	14.9
D cotton	3.42	21.7
E cotton	3.56	26.7
F cotton	3.20	13.9
R bld*	0.71	-
A bld	0.88	23.9
B bld	0.88	23.9
C bld	0.86	21.1
D bld	0.87	22.5
E bld	0.84	18.3
F bld	0.85	19.7

* *bld* is factory blend polyester/cotton

In table 3 are given intensity values of reactive dye (*K/S*) and percentage of dye intensity increase (*I*) after alkaline treatment. A trend of increased absorption of reactive dye on all modified samples was observed. For increased absorption of reactive dye from 64 to 143% on alkalized polyester samples, new incorporated OH groups on the ends of depolymerized polyester chains are responsible.

Cotton fabric samples after alkaline treatment absorb 14–28% more dye as a result of changes in supramolecular structure during hot alkaline treatment. When cotton is treated with an alkaline solution a good mercerization effect is achieved because cellulose crystal structure is modified and percentage of amorphous regions is increased [15]. By increasing non crystal regions, swelling of fiber is increased and dye penetrates more easily into fiber. Modified polyester fabrics have better concurrent dyeing with cotton and it can be asserted that intensity increase of 18–24% on factory blend is a contribution of both fibers. On modified samples, standard values for fixation degree *F* and dye fastness (table 4) are observed indicating the stability of dye-fiber bond.

One-bath dyeing of polyester/cotton blend with reactive dyes after chitosan treatment

One way to achieve multifunctional properties of textile, including better absorption, is deposition of biodegradable polymers with functional groups. Chitosan is a biopolymer possessing reactive amino and

Table 4

FASTNESS OF C.I. REACTIVE RED 3 ON ALKALI SOLUTION PRETREATED SAMPLES				
Sample	**Fastness**			**Fixation degree, *F***
	Washing	***Rubbing-dry***	***Rubbing-wet***	
R polyester	3-4	4-5	4-5	0.78
A polyester	3-4	4-5	4-5	0.77
B polyester	3-4	4-5	4-5	0.78
C polyester	4	4-5	4-5	0.77
D polyester	4	4-5	4-5	0.81
E polyester	4	4-5	4-5	0.79
F polyester	4	4-5	4-5	0.76
R cotton	4	5	4-5	0.83
A cotton	4	5	4-5	0.81
B cotton	4	5	4-5	0.80
C cotton	4	5	4-5	0.81
D cotton	4	5	4-5	0.80
E cotton	4	5	4-5	0.79
F cotton	4	5	4-5	0.78
R bld	3-4	5	4-5	0.83
A bld	3-4	5	4-5	0.81
B bld	3-4	5	4	0.80
C bld	3-4	5	4-5	0.80
D bld	4	5	4-5	0.81
E bld	4	5	4-5	0.82
F bld	3-4	5	4	0.80

hydroxyl groups and owing to its unique characteristics it is suitable for many applications on textile. Chitosan absorbs anionic dyes and has recently attracted scientific and industrial interests as a suitable sorbent for dyes in textile dyeing and wastewater treatment.

After treatment of polyester fabrics in chitosan solution, dramatically increased absorption of reactive dye was observed and the maximal intensity was achieved with fabric treated in highest concentration of chitosan solution (table 5). On cotton fabric, too, simultaneously dyed with polyester fabric, C.I. Reactive Red 3 dye intensity increases uniformly with concentration of chitosan treatment solution. Hydroxyl groups of chitosan layer on the surface of pretreated fibers represent binding sites for additional quantities of reactive dye and this treatment multiplies polyester capacity so that color on factory blend components is better leveled giving higher *K/S* value which is 55% higher at maximal chitosan concentration compared to untreated fabric.

On all samples, values for fixation degree *F* and color fastness (table 6) were high. Higher dye yield means lower dye content in waste water and is based on reaction of chitosan hydroxyl group with reactive center of monochlor thiazine (MCT) dye. It is known that MCT reactive dye can react with cellulose hydroxyl group after adjusting alkaline *p*H with Na_2CO_3. Moreover, under alkaline conditions, deprotonation of chitosan hydroxyl group also occurs [16]:

Table 5

SIMULTANEOUS DYEING RESULTS OF POLYESTER, COTTON AND FACTORY BLEND SAMPLES PRETREATED WITH ALKALI SOLUTION		
Sample	***K/S***	***I*, %**
R polyester	0.028	-
H_1 polyester	0.117	317
H_5 polyester	0.445	1 489
H_{10} polyester	0.528	1 785
R cotton	2.81	-
H_1 cotton	3.07	9.2
H_5 cotton	3.20	13.9
H_{10} cotton	3.30	17.4
R bld	0.71	-
H_1 bld	0.83	16.9
H_5 bld	0.94	32.4
H_{10} bld	1.10	54.9

Note: H_1 is treatment with chitosan solution, 1 g/dm^3;
H_5 – treatment with chitosan solution, 5 g/dm^3;
H_{10} – treatment with chitosan solution, 10 g/dm^3

Table 6

FASTNESS OF C.I. REACTIVE RED 3 ON CHITOSAN TREATED SAMPLES				
Sample	**Fastness**			**Fixation degree, *F***
	Washing	***Rubbing-dry***	***Rubbing-wet***	
R polyester	3-4	4-5	4-5	0.78
H_1 polyester	3-4	4-5	4-5	0.77
H_5 polyester	3-4	4-5	4-5	0.78
H_{10} polyester	4	4-5	4-5	0.77
R cotton	4	4-5	4-5	0.76
H_1 cotton	4	5	4-5	0.81
H_5 cotton	4	5	4-5	0.82
H_{10} cotton	4	5	4-5	0.81
R bld	4	4-5	4-5	0.78
H_1 bld	3-4	5	4-5	0.81
H_5 bld	3	5	4-5	0.82
H_{10} bld	3	5	4-5	0.81

$$CH_2OH + OH^- \leftrightarrow -CH_2O^- + H_2O \qquad (6)$$

so that chitosan hydroxyl group can bind reactive dye covalently under alkaline conditions as with cellulose alkaline group in dyeing process.

One-bath dyeing of alkalized and chitosan treated polyester/cotton blend with reactive dye

Hybrid treatments of textile material combining surface modification of fibers and deposition of compound with higher dye adsorption capacity are potentially the most effective for improved dye yield from technological solution. On combined treated samples of polyester fabric (alkalization and 5 g/dm^3 chitosan solution treatment) quantity of C.I. Reactive Red 3 is dramatically increased so that dye intensity is increased

Table 7

SIMULTANEOUS DYEING RESULTS OF POLYESTER, COTTON AND FACTORY BLEND SAMPLES PRETREATED WITH ALKALI AND CHITOSAN SOLUTION (5 g/dm^3)		
Sample	***K/S***	***I*, %**
R polyester	0.028	-
AH_5 polyester	0.52	1 757
BH_5 polyester	0.51	1 721
CH_5 polyester	0.53	1 792
CH_5 polyester	0.57	1 935
EH_5 polyester	0.50	1 685
FH_5 polyester	0.63	2 150
R cotton	2.81	-
AH_5 cotton	3.65	29.9
BH_5 cotton	4.16	48.0
CH_5 cotton	3.34	18.9
DH_5 cotton	4.63	64.8
EH_5 cotton	3.56	26.7
FH_5 cotton	3.22	14.6
R bld	0.71	-
AH_5 bld	1.46	105.6
BH_5 bld	1.19	67.6
CH_5 bld	1.47	107.0
DH_5 bld	1.40	97.2
EH_5 bld	1.33	87.3
FH_5 bld	1.18	66.2

Table 8

FASTNESS OF C.I. REACTIVE RED 3 ON ALKALI AND CHITOSAN SOLUTION PRETREATED SAMPLES				
Sample	**Fastness**			**Fixation degree, *F***
	Washing	***Rubbing-dry***	***Rubbing-wet***	
R polyester	3-4	4-5	4-5	0.78
A polyester	3-4	4-5	4-5	0.77
B polyester	3-4	4-5	4-5	0.78
C polyester	4	4-5	4-5	0.77
D polyester	4	4-5	4-5	0.81
E polyester	4	4-5	4-5	0.78
F polyester	3-4	4-5	4-5	0.77
R cotton	4	5	4-5	0.83
A cotton	4	5	4-5	0.81
B cotton	4	5	4-5	0.80
C cotton	4	5	4-5	0.79
D cotton	4	5	4-5	0.80
E cotton	4	5	4-5	0.80
F cotton	4	4-5	4-5	0.79
R bld	3-4	5	4-5	0.83
A bld	3-4	5	4-5	0.81
B bld	3-4	5	4	0.80
C bld	3-4	5	4-5	0.80
D bld	4	5	4-5	0.81
E bld	4	5	4	0.80
F bld	3	4-5	4	0.79

16,8–21,5 times (table 7). Cotton fabric samples treated with combined methods and dyed in the same solution with polyester fabric also have higher absorption capacity and fixation degree and the yield is higher, up to 65%. Percentage of reactive dye intensity increase on blended fabric was 66–105% and it is significant in terms of economy and environmental protection, because with higher dye utilization degree from technological solution, the required dye quantity to achieve a specified color shade is reduced and dye quantity reaching waste water is also reduced. Fixation degree and fastness of reactive dye (table 8) were not reduced because cellulose and chitosan hydroxyl groups fix the dye by covalent bond.

CONCLUSIONS

One bath dyeing of cotton-polyester blends with one dye progressively attracts scientific and industrial interest because it can to a great extent facilitate color matching and lower production costs. In this respect, modification and pretreatment with suitable compounds have been studied in order to improve fiber sorption properties.

Alkaline treatment modifies physically and chemically the surface of polyester fiber and at the same time mercerizes cotton favorably affecting absorption of C.I. Reactive Red 3 dye resulting in 24% increase of color intensity on factory blend. Deposition of chitosan biopolymer on all samples increases, proportionally with concentration, reactive dye absorption, especially on polyester. Hybrid treatment combining alkaline and chitosan treatment is the most effective resulting in 100% increase of reactive dye intensity on factory blend with high color matching on components and with retained high dye fixation degree and color fastness it can enable a new approach to textile dyeing and finishing.

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INDUSTRIA TEXTILĂ ÎN LUME

GRUPUL KURABO ŞI-A EXTINS PRODUCŢIA DE CONFECŢII TEXTILE

Producătorul de materiale textile ***P.T. Kurabo Manunggal Textile Industries*** (Kumatex), din Jakarta/Indonezia, şi producătorul de confecţii ***P.T. Akurabenitama*** (AKM), din Jawa Barat/Indonezia – o filială a Grupului Kurabo din Osaka, în cooperare cu alţi parteneri, printre care şi ***Agro Group***, din Jakarta/Indonezia, şi-au extins liniile de producţie, de la filare la ţesere, vopsire, finisare şi confecţii. Conform planurilor elaborate, urmează ca investiţia în confecţii să se dezvolte, pentru a putea face faţă atât cererii de ţesături şi fire de pe piaţa internă a Indoneziei, cât şi volumului de exporturi către Japonia. Pe parcursul anului fiscal în curs, compania şi-a planificat o producţie totală de 1,35 milioane de bucăţi de articole de îmbrăcăminte.

Melliand International, mai 2012, p. 66

Experimental research on establishing the level of bullets protection for a ballistic protection structure

IONUȚ DULGHERIU
MANUELA AVĂDANEI
SIMONA BADEA
IOAN SAFTA

REZUMAT – ABSTRACT

Cercetări experimentale privind stabilirea nivelului de protecție antiglonț a structurilor de protecție balistică

Proiectarea structurilor destinate protecției balistice reprezintă o direcție de dezvoltare cu un potențial deosebit. Progresele importante obținute de cercetătorii, proiectanții şi fabricanții unor materiale performante, utilizate pentru protecția balistică individuală, au permis relansarea, la acest nivel, a competiției dintre proiectil şi blindaj. Lucrarea prezintă modul de realizare şi de testare a şase variante de pachete balistice, realizate din kevlar laminat, kevlar XP şi țesătură metalizată, în cadrul Laboratorului de Încercări pentru Protecție Balistică şi Pirotehnică, de la Centrul de Cercetare Ştiințifică pentru Apărare CBRN şi Ecologie.

Cuvinte-cheie: echipament de protecție balistică, nivel de protecție balistică, standarde, proiectil, calibru

Experimental research on establishing the level of bullets protection for a ballistic protection structure

A great potential direction of development is the structures design for ballistic protection. Significant progress achieved by scientists, designers and manufacturers of advanced materials, used for individual ballistic protection, allowed, at this level, the competition revival, between projectile and armor. The paper presents the way of achieving and testing 6 variants of ballistic packages made of Kevlar laminate fabric, Kevlar XP and metallic fabric, within the Testing Laboratory for Ballistic and Pyrotechnic Protection of the Scientific Research Center for CBRN Defense and Ecology.

Key-words: ballistic protection equipment, ballistic protection level, standards, projectile, caliber

Ballistic protection structures design have as main input data, the type and level of threats the wearer is exposed, during battles.

Because of the fact that it is impossible for a protection structure, whether is individual equipment, armoured and pillbox cars, to ensure total protection against all the threats, it is very important for the protection structure's user to specify to the designer, the degree and the level of protection required. Under these conditions, the designer of ballistic protection structure usually has to solve a problem of optimization that takes into account the user's requirements, the technical possibilities of meeting those requirements, product weight and its costs.

One of the first records on the use of light armour comes from medieval Japan, when there was used protective clothing from silk. At the end of the nineteenth century, the American soldiers began to study the possibility of manufacturing protective equipment from silk. The project has become attractive after the assassination of President William Mc Kinley, in 1901. Although this equipment has shown good properties of protection against bullets of low speed (below 150 m/s), it was overcome by the weapons industry's development, that started to produce different types of ammunition, which reached speeds over 300 m/s. This, and the high cost of silk, made this project to be abandoned, although in 1919, at the Patent Office in the United States had being already registered several model types of protective equipment.

Another generation of bulletproof vest appeared during the Second World War, the so-called "Flak Vest". Those were made of ballistic nylon and, despite providing good protection from splinters, were ineffective against bullets.

In 1970, DuPont discovered the fabric from polyaramidic fiber called Kevlar and opened new roads for ballistic protective equipment industry.

Significant progress achieved by researches in the chemistry field, in recent decades, have materialized, among other things, into polymers that have a mechanical strength which exceeds up to ten times that of steel, and manufacture of ceramic materials with hardness close to diamond. These new materials and composite structures which includes them, allowed the competition revival between the projectile and armour, at the individual protection equipment level.

Designed structures testing must begin on the first phase of development, so any non-compliance arising from the variations made and requirements can be resolved in time so that the final product manufacture won't be affected. Later, in the acquisition process of ballistic protection equipment, testing activities are essential to ensure purchased product compliance, with the requirements of the procurement specifications.
Testing must be carried out accordingly to the approved procedures and only by the accredited structures. In Romania, the only accredited structure for testing military and civilian, ballistic protection equipment is the Testing Laboratory for Ballistic and Pyrotechnic Protection (TLBPP) of the Scientific Research Center for CBRN Defense and Ecology (fig. 1).
The laboratory has testing procedures for most of the threats faced by ballistic protective equipment (BPE): bullets, splinters, stabbing, shock wave resulting from the explosion, impacts. The testing methods are standardized methods and laboratory developed methods, based on sole studies and researches.

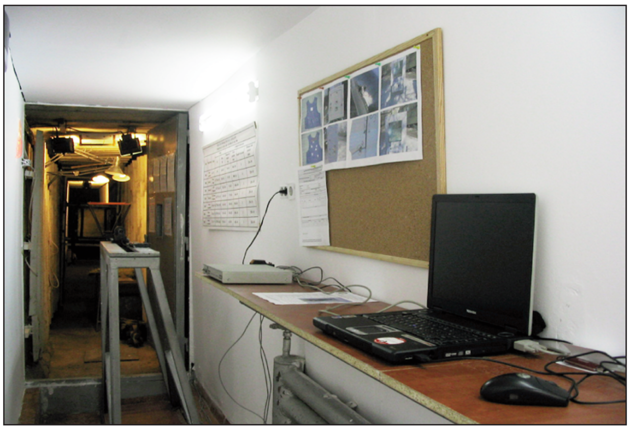

Fig. 1. A picture of the TLBPP shooting room

MATERIALS USED IN INDIVIDUAL BALLISTIC PROTECTION

The best-known materials with application in individual ballistic protection are: fiberglass, carbon fiber, boron fiber, organic fibers, acrylic fibers, nylon fibers.
Fiberglass (fig. 2) is the oldest and most common fiber of those with remarkable performance. It is manufactured from 1930. Although the first versions were very resistant, they were relatively inflexible, with very few applications. Fiberglass of today has more varied properties, being used in different fields.
The most common types of glass are [1]:
Type E (electrical) – with lower alkali content (max. 2%), excellent tensile strength and electrical resistance. Impact strength is quite small. This is the type of glass used to produce reinforced materials, with the lowest price of production.
Type °C (chemical) – is the most resistant to chemical attacks. It is used in corrosive environments as a surface layer.

Fig. 2. Fiberglass

Type S (or R, T) – the best glass. Fibers obtained from this type of glass are to 40–50% more resistant than type E fiber, being used to obtain composite materials with special properties, for the aerospace industry in particular.
Quartz – a high-silica glass with outstanding mechanical properties and excellent resistance to high temperatures (above 10 000 °C). But the manufacturing process leads to extremely high prices (14 mm – 74 pounds/kg, 9 mm – 120 pounds/kg).
Type D – are obtained fibers with remarkable dielectric properties.
Carbon fibers shown in figure 3 can be processed to obtain the desired strength. Various types of carbon fiber differ in flexibility, electrical conductivity, thermal and chemical resistance. Primordial factors governing the physical properties are represented by the degree of carbonization (carbon content, usually less than 92% by weight) and the orientation of carbon layers. Fibers for commercial purpose have appeared on the market in 1960 and contain a wide range of crystalline and amorphous products.
One can consider that carbon fibers make the transition between inorganic and organic fibers and together with the glass fibers have opened the age of composites materials. They were first used by the military and the aviation industry, and later in the automotive industry.

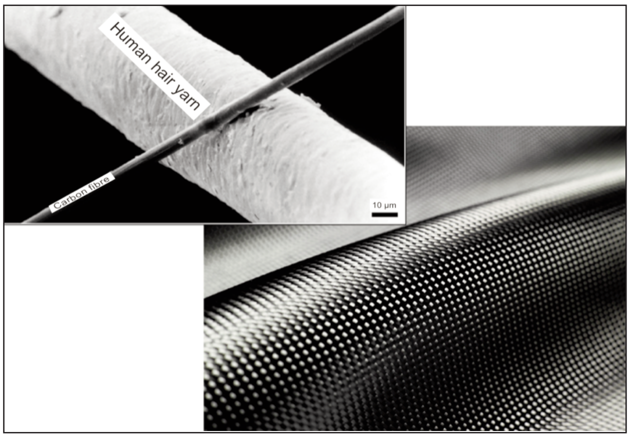

Fig. 3. Carbon fiber

Carbon fibers can be produced by heat treatment and pyrolysis of different polymeric precursors such as rayon, polyacrylonitrile, aromatic polyamide, phenolic resins, and so on. In the recent years, carbon fibers and graphite fibers from materials like tar have been introduced into manufacturing. The term “graphite fiber” is used improperly, as this comes not from graphite fibers, but from carbon fibers with a heat treatment at over 20 000 °C.

Boron fibers are carbon fibers or metal fibers coated with boron, to improve fiber properties. However, extremely high cost of the fiber causes it to be used only in special high-temperature applications and specialized sports equipment. Hybrid carbon-boron may have better properties than any other simple fiber.

Aramid fibers (fig. 4) were introduced into commercial production in 1971, being polyamides derived from aromatic acids and amines. Due to the stability of aromatic rings, plus amide bond strength (due to conjugation with aromatic structures), aramid fibers have physical and mechanical properties much higher than aromatic polyamides (nylon). Para-aramids based on terephthalic acid and p-phenylenediamine or p-aminobenzoic acid, have better properties than those with links to Meta position of benzene nuclei. The explanation is the higher degree of conjugation and geometry closer to linear. High impact strength of aramid fibers make them “popular” among the materials designed to achieve bulletproof vests. Among the most popular marketable varieties are Kevlar and Twaron.

In case of usage on composite materials, fibers finishes are made for many applications (including ballistic), aramid fibers are not finished. Aramid fiber strength and module are higher than those of any organic fiber, but not greater than carbon fibers; aramid fibers are also less flexible than carbon fiber or fiberglass. Mechanisms of fiber energy absorption are represented schematically in figure 5.

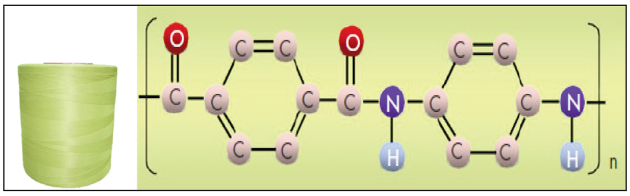

Fig. 4. Molecular structure of aramid fibers [2]

Polyethylene fibers are among the most resistant fibers, 10 times stronger than steel and up to 40% stronger than aramid fibers. Due to these properties, are used in many applications such as bulletproof vests, helmets, armoured vehicles, protective equipment (fig. 6).

Polyethylene fibers with higher macromolecular density have a simple structure consisting of [CH2-CH2]n (100 000) repeating unit. Outstanding mechanical properties are derived from summing the weak Van der Waals bonds between molecules. The most common fibers used in ballistic protection are Spectra and Dyneema fibers that are obtained by extracting it from gel and the Tensylon fiber made from pressed powder. Disadvantages of these fibers are the upper limit of the maximum use of temperature at 1 200°C, lower to aramid fibers and reduced compressive strength. Because of these issues, thermoplastic or thermosetting resins, the range that these fibers can be combined is limited.

PBO Fibers – polybenzobisoxanole (fig. 7) were developed in order to obtain better material than those of aramid fibers, but has the same disadvantage of low resistance to compression. Decomposition temperature of these fibers is 550°C and 450°C, for aramid fibers. The most popular PBO fiber brand on the market and the one that found much success and applicability in the manufacture of the personal ballistic protective equipment is zylon.

PYPD fibers – polypyridobisimidazole (fig. 8) represents a new generation of rigid fiber called M5 [3], currently developed by the Akzo Nobel company, which has some special properties, and the most important are:

– has a similar structure to the PBO fiber, but due to strong intermolecular hydrogen links, has a significantly higher compressive strength than PBO fibers;
– decomposition temperature is around 530°C;
– area density of ballistic protection systems is expected to decrease up to 40–60%, less than using Kevlar KM2.

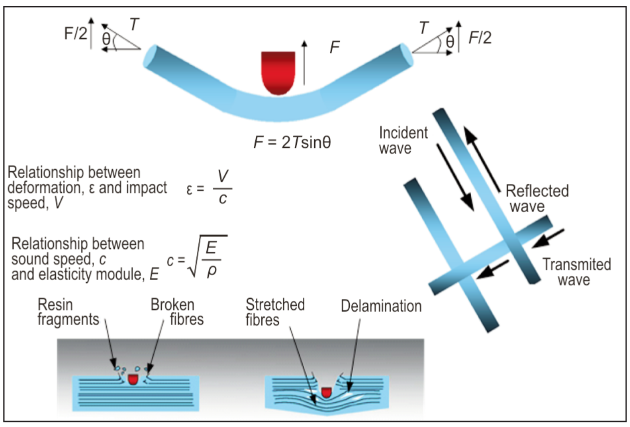

Fig. 5. Mechanisms of fiber energy absorption [2]

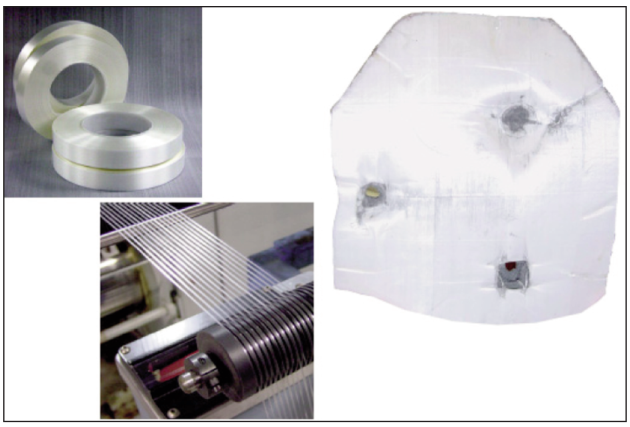

Fig. 6. Polyethylene fiber and ballistic protective equipment

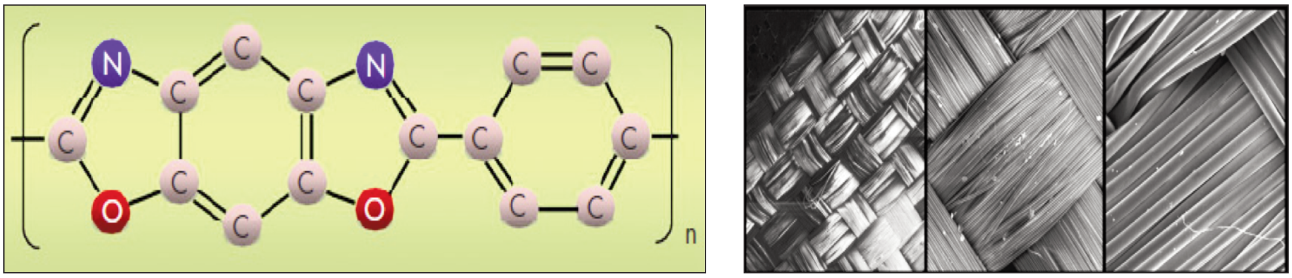

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Fig. 7. PBO fibers, molecular structure and fabric [2]

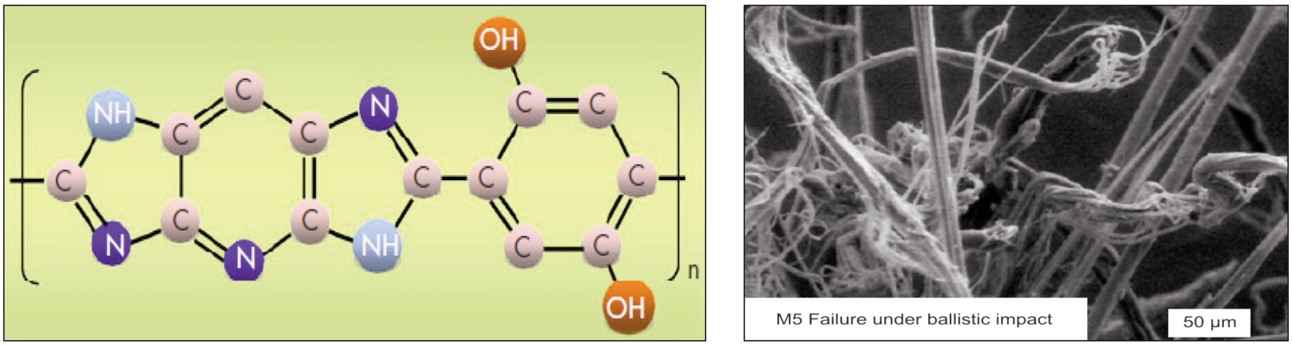

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Fig. 8. PYPD fibers, molecular structure and impact behavior [2]

TESTING METHOD ON BULLET ACTION

Bullets have remained a major threat to life and physical integrity of the fighters. If in the classical war the most dangerous were splinters, in other types of conflict, including on peacetime, bullets remain the main cause of casualties.

It is well known that bullets have great differences among themselves in size, mass, initial speed, shell, heart, head, and so on. Manufacture of individual protective equipment to ensure total security for all these bullets is a practical impossibility, given the drastic constraints imposed by the limit of the total mass of equipment that a fighter can carry.

Based on experience in several countries, including Romania, there have been adopted standards considering the bullets protection classes and methods of enclosing armour into a certain class.

Testing the behavior of individual protective equipment, materials and structures designed to their production, aims to highlight two characteristics: resistance to penetration and trauma appreciation of the body that is under the equipment, at the impact.

Assessing the total penetration of a structure it is simple in many cases, when is found that there is a hole with a diameter at least equal to the bullet caliber and it entirely passes through it. For the situations where the bullet is fragmented at the impact with the target and only fragments of it pass through armour, it is used, in some cases, a witness plate. It consists of a thin film of aluminum alloy applied at 5–10 cm behind the target. It is considered that the projectile impact (bullet or splinter) with the target has produced a total penetration when the witness plate was perforated.

The witness plate method is effective but cannot be applied when is necessary the placing of the tested material directly on a support material with permanent deformation.

When testing individual ballistic protection equipment, the trauma is estimated by the depth of the imprint that forms into the plasticine on which the sample is set. The standard test used is NIJ STANDARD 0101.04/2000 [4] approved by the U.S. Department of Justice. This standard recognizes as satisfying the materials and equipments where the imprint in the plasticine does not exceed 44 millimeters. Other standards drop that value down to 25 mm or 20 mm. In Romania, the maximum acceptable value is 44 mm. Romanian Standard SMT 40202/99 [5] takes the test method and American ammunition and adds commonly used ammunition by the former Warsaw Pact armies. In figure 9 are presented some ballistic protection equipment tested under LIPBP.

Fig. 9. Tested ballistics protective equipments

Fig. 10. Jericho 9 mm caliber revolver and bullets of 9 mm caliber

Fig. 12. Oehler 35 type optoelectronic chronograph

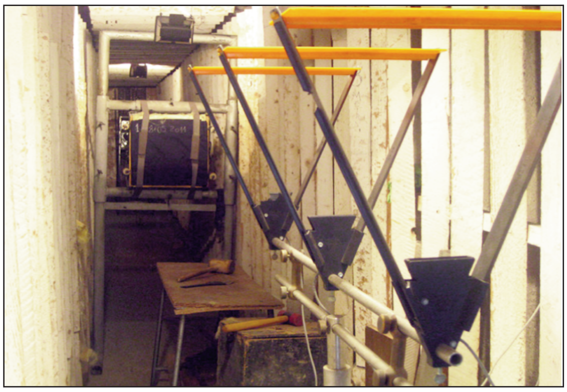

Fig. 11. Placing the sample into the target range

EXPERIMENTAL RESEARCH ON ESTABLISHING THE STRUCTURE OF A BALLISTIC PACKAGE

The purpose of these tests was to determine the level of ballistic protection according to NIJ 0101.04/2000 for a protective structure made of layers of Kevlar and stainless steel fabric. In the absence of any information on the level of protection, was started with the lowest level that can be tested at LIPBP namely IIA level.

This means: a shot with a bullet of 9 mm caliber (8 g bullet weight) and speed of 350 m/s without causing perforation (fig. 10). The ballistic package is positioned at a distance of 5 m, on a box with ballistic plasticine that mimics the human body consistency (fig. 11). Projectile velocity is measured with an Oehler 35 type optoelectronic chronograph shown in figure 12.

The initial ballistic package that was tested (fig. 13) was perforated by the first blow and has the following structure: 1 layer of laminate Kevlar, 3 layers of metallic fabric, 7 layers of 802 Kevlar.

In order to increase the ballistic resistance there have been added two layers of metallic fabric, but it was not enough, and this second sample was also perforated. There have been obtained a total of 3 samples by successively adding new layers of laminate Kevlar, Kevlar 802 fabric and metallic fabric.

The last one of this set was very good, the bullet was stopped after 3 layers of XP Kevlar, the imprint measured in the plasticine had 15 mm and it was made of: 4 layers of XP Kevlar, 3 layers of laminate Kevlar, 8 layers of metallic fabric, 13 layers of Kevlar 802.

Finally, for the sixth sample, the metallic fabric layers were removed, and the result was very good, the bullet hadn't perforated and the traumatic imprint had been of 18 mm.

Therefore, it was observed that the metallic fabric does not have a significant influence on the level of ballistic protection.

Accordingly to the standards, a complete characterization of the protective structure is made by 6 shots (4 at 90 degree angle and 2 at 30 degree angle). In

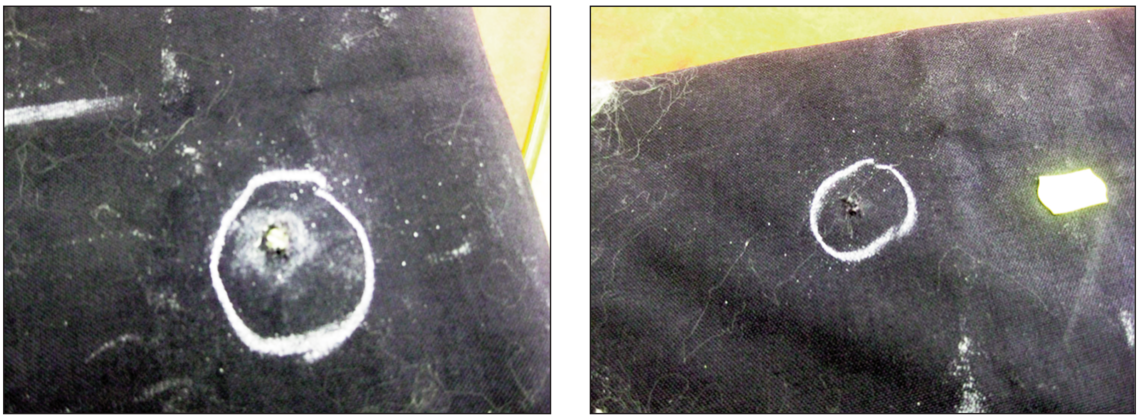

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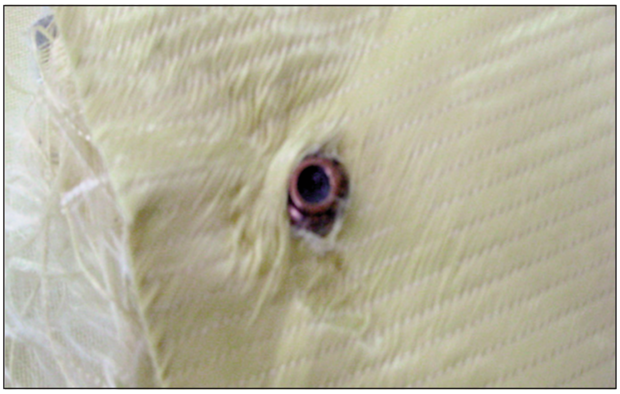
Fig. 13. Perforated ballistic package (front and rear)



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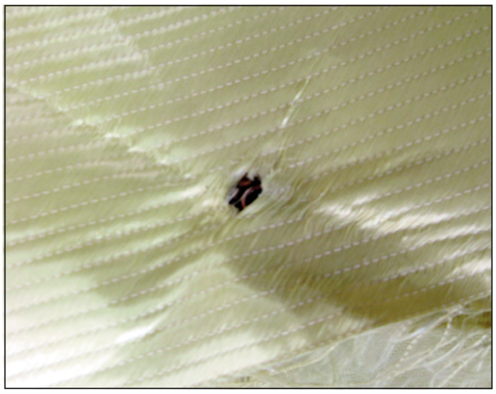

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Fig. 14. Bullet stopped in Kevlar layer

this case, because we did not have a sufficient number of samples, we estimated the level of ballistic protection, which would be, II A, according to NIJ 0101.04/2000.

CONCLUSIONS

Search directions for ballistic protection have been materialized into:

- design and implementation of modern and effective resorts for individual protection;
- design and implementation of resorts for protection of important objectives;
- obtaining new materials with remarkable qualities to those considered conventional;
- design and implementation of adequate technical resorts for improvised explosive devices intervention and neutralization;
- defining conditions regarding trials, material and equipment testing, so they will be fully useful, at an affordable cost and with accessible technological possibilities.

Significant progress achieved by scientists, designers and manufacturers of advanced materials, used for individual ballistic protection, allowed, at this level, the competition revival, between projectile and armour. For the next decade it is expected a progress in obtaining materials produced by bio-technology and genetic modification.

By these methods, it is desired to obtain a correspondent to the spider thread. These perspectives will influence ballistic protective equipment that will become lighter and more durable.

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Development of the Slovenian textile and clothing industry

BRUNO ZAVRŠNIK VOJKO POTOČAN

REZUMAT – ABSTRACT

Dezvoltarea industriei de textile şi confecții din Slovenia

Industria textilă şi de confectii din Slovenia a început faza de tranziție şi procesul de restructurare a țării. A existat un moment în care numărul de companii şi de angajați a scăzut semnificativ. Când Slovenia a intrat în U.E., competitivitatea industriei a scăzut din cauza importurilor ieftine de produse textile, în principal din țările asiatice. Criza economică şi schimbările majore din industria textilă europeană au impus adaptări rapide şi eficiente la situația globală a industriei. Prin urmare, Uniunea Europeană a lansat proiecte ce vizau platforme tehnologice şi centre de excelență. Slovenia a adoptat, de asemenea, proiecte similare de dezvoltare a unor platforme tehnologice şi de integrare a firmelor textile şi de confecții în cadrul unor clustere, ceea ce urma să conducă la o competitivitate mai mare a industriei de confecții.

Cuvinte-cheie: industria de textile şi confecții din Slovenia, platforme tehnologice textile slovene, tendințe textile şi vestimentare

Development of the Slovenian textile and clothing industry

The Slovenian textile and clothing industry began the transition phase and process of restructuring in the country. A number of firms and employees were significantly reduced at the time. When Slovenia entered the EU, the competitiveness of the industry had declined due to cheap imports of textile products mainly from Asian countries. The economic crisis and major changes in the European textile and clothing industries required faster and more effective adaptations to the current global situation in this industry. Thus, the EU began with projects concerning technology platforms and centers of excellence. Slovenia also has adapted similar projects with technological platforms and the integration of textile and clothing firms into clusters, which should lead to greater competitiveness for the Slovenian textile and clothing industry.

Key-words: Slovenian textile and clothing industry, Slovenian textile technological platform, textile and clothing trends

The textile and clothing industry is one of the largest industrial processing branches in the world. The number of employed workers and the share of social products within the industrial sector actually make textiles and clothing the leading business in many countries. It spans from the capital, most intensive fields (spinning, weaving, knitting, textile coating) to the classic, labor-intensive work (clothes confectioning).

In many countries, the textile industry represents one of the most important industrial sectors, and along with proper restructuring, it is anticipated to stay the most important industrial sector in the future [1].

The European textile and clothing industry has a tradition of leadership in innovation, fashion and creativity, and despite intensifying global competition, it still remains one of the top European sectors. The industry is one of the key players in world trade. In fact, textiles exports are the most traded in the world and clothing exports is third.

The uncertainty that has been present in the textile industry of the developed world – particularly in Europe – is a consequence of the continuous and rapid changes taking place in this field in the last few years. These changes have lead to the restructuring and reorganization not only of production, but of the entire industrial branch. The result of these changes is a substantial decrease in staff numbers in the developed parts of the world, while presenting a way into industrialization for countries whose economies are still developing [2, 3].

In the developed parts of the world, the textile and clothing sector has been subjected to a series of radical changes due to a combination of technological changes, the growth of various production costs, and the appearance of important international competitors. As a reaction to past competitive challenges, the textile and clothing industry of the developed world started a lengthy restructuring and modernization process while implementing technological development. In doing so, companies have improved their competitive advantage with a substantial reduction in facilities and processes, closing down mass production or eliminating the production of simpler fashion products, and focusing instead on a broad spectrum of various products with high added value.

Similar to other companies, the textile and clothing companies in Slovenia are continually facing changes and demands for rapid adaptation stemming from the environment. In the textile field, the restructuring processes has been even more obvious in Slovenia, including the cessation of mass production and its movement to countries with a cheaper labor force and a general reduction of human personnel, such as

Asian countries. The textile and clothing industry, therefore, has become more and more specialized in products with special application and products intended for market niches.

SLOVENIAN TEXTILE AND CLOTHING INDUSTRY IN THE LAST DECADE

Since 2000, the Slovenian textile and clothing industry has been characterized by continued decline in production, income, exports and, consequently, the number of employees. During this period, the Slovenian clothing industry was highly export oriented, since its production capacities were still significantly greater than the needs of the domestic market. Thus, in 2000, the exports accounted for 55% of total revenues and 50% in 2010. The largest share of Slovenian clothing industry production in 2000 was for finishing operations.

The Slovenian clothing industry has always been the largest export partner of the European Union, specifically Germany, Austria and Italy. In fact, the Slovenian clothing industry exported more than 80% of total exports of clothing products in the countries of the European Union in 2000, while in the past year the share of exports of this industry was only 66.2%. Apparel exports to the European Union accounted for the largest proportion of exports of garments to Germany with 35.3.

When Slovenia gained independence in 1991, the clothing industry employed 33,712 workers, representing almost 8% of total employment in the manufacturing industry. With Slovenia's accession into the European Union on May 1, 2004, the decline in the export clothing industry has not stopped, and the adoption of the euro did not significantly affect Slovenia's competitive position in the global market. Reducing the number of employees in the textile and clothing industry in Slovenia was not only due to the bankruptcy of companies, but also a continuous decrease in the number of employees in businesses that were optimizing production capacity and cutting costs. The textile and clothing industry employed 14,142 in 2000, and at the end of 2009, only 8,058 workers were employed, which is four times less than in 1991. From 2000 to 2009, the number of firms did not changed significantly since after their bankruptcy proceedings, several new businesses restarted. The businesses mainly covered trade in apparel and the development of local brands, with the ambition of becoming fashion companies. However, from 2000 to 2009, the revenue of textile and clothing businesses decreased by approximately 13%.

MODELS OF BUSINESS COOPERATION IN THE TEXTILE AND CLOTHING INDUSTRY IN SLOVENIA

In the modern business environment, companies establish and maintain their competitive advantage not just by optimizing their own potentials, but above all with the capability of using foreign resources and by connecting into an integrated business process (i.e., work process). The need for connecting companies and pooling resources stems from the requirement of the global market to achieve competitiveness in price, time, and quality [4, 5]. The concept of organizational restructuring of companies has become more and more popular since the 1990s and is based on the network approach. Particularly in the last decade, the networks formed have gained new importance [6].

Due to mutual connections between different companies, so-called regional network connections have become prominent. Regional network connections unite small- and middle-sized companies with the objective of connecting their resources in a particular field of operation. The most typical example of a regional network connection is called a cluster. Clusters are connections between companies in particular fields with suppliers, research institutions, and local developmental organizations. The cluster, as a type of regional inter-organizational connection, has been implemented in the Slovenian environment as well.

The accelerated implementation of clusters started more than 20 years ago by connecting companies within an individual geographic area. The most typical regional network connections can be found in northern Italy (Emilia Romagna), southern France, Silicone Valley in the U.S., and so on [7]. A new impetus and development exceeding the regional form of connection was seen in clusters in the 1990s. In this period, clusters became prominent for sectorial, multi-sectorial, and regional connections.

The theoretical bases of chains of suppliers and clusters can be read about in the works of the acclaimed management theoretician Michael Porter [9], who emphasized the level, development, and encouragement of inter-entrepreneurial connections as an important element when achieving competitive advantage for individual countries. Also, in his later works, Porter emphasized regional clusters as a form of non-formal connection between different groups that connect, cooperate, and compete with each other.

In Slovenia, clusters have become very popular [10], which was highly encouraged by the Ministry of Economy of the Republic of Slovenia, whose officials saw the encouragement of companies as a measure for providing long-term competitive advantage.

The Slovenian textile and clothing cluster

In the beginning of 2000, the Ministry of Economy of the Republic of Slovenia started implementing a project called *"Encouraging company cooperation, specialization in production chains, and the joint development of cluster-modeled international markets"* [1]. In 2003, the first Slovenian textile cluster, SLOTIC, was established. To begin with, it connected eight textile producers, two companies from the group of buyers, two laundries, and three knowledge centers. The main objective of linking textile companies into clusters was to increase their competitive abilities, create recognizability (particularly in developed markets), ensure an increased level of specialization, and unify individual resources in the field of development [4].

Technological platform

Of course, clusters are not the only form of inter-organizational cooperation that has gained support within the EU and Slovenian economic development incentives. Cooperation in the field of technological development (e.g., technological networks, technological platforms, centers of technological transfer etc.) has become increasingly prominent.

Technological platforms are mechanisms of developmental politics established by the EU. They connect challenges within the different fields and determine strategic advantages and opportunities for individual technological sectors. They were recognized as increasingly important and beneficial for various fields in Slovenia as well. In the research and development field, they encourage target-directed investments and a more efficient approach to innovation, as well as the coordinated operation of European and national research programs.

There is an emphasized economic initiative in technological platforms. They are an open structure, which means that in order to be efficient, they have to include all key factors – from the economy to institutes, universities, public institutions, and the state – so as to encourage partnerships with other sectors and, as such, present the basis for a political dialogue.

The Slovenian Textile Technological Platform

Changes of the market are fast and, consequently, the industry must adapt fast because in exceptionally competitive conditions, only the companies that follow advanced technologies and are directed toward development will survive. To support achievement of their aims, in November 2005, a total of 22 companies and development & research (D & R) and educational institutions established the Slovene Textile Technological Platform (STTP).

The STTP is a forum of Slovene textile and clothing industry sharers. It connects companies with research and educational institutions whose basic activity is linked to the textile industry. The strategic direction of these companies, which are associated in the framework of the STTP, is development of the top-most innovative textile products and services. Thus, the direction of the research and educational institutions is to support these activities, which will enlarge the competitive abilities of the companies.

The vision of the STTP is a permanent Slovene textile industry competitive position based on knowledge. It is planned on the basis of the developmental potential of the Slovene textile industry as a dynamic, innovative business and the R & D nets, which are based on multidiscipline knowledge, flexibility and direction toward customers. Among the successful textile companies, most are small and medium enterprises that do not have a sufficient critical mass of knowledge. Therefore, the aim of such an association of companies in partnership with universities and knowledge centers in the framework of the technological platform is to connect with a potential of knowledge for technological progress of the industry and drive improvement of innovation conditions. Thus, the STTP has set the following aims:

- Preparation and implementation of a strategic research agenda;
- Association of companies, technological centers, and institutions of knowledge into an effective system that will perform research activities for the needs of the industry;
- Preparation and implementation of activities in the field of education and standardization;
- Developmental projects of new products and products for new fields of use.

The research priorities of the STTP focus on research fields that have a long-term influence on the development of the textile and clothing industry, that is:

- Moving from the usual to more specialized products, based on highly technological processes along the entire chain of values of fiber textile/clothing;
- The implementation and expansion of textiles into numerous industrial sectors and new areas of textile use;
- Moving from mass production to customized production and the personalization of products, along with intelligent production, logistics, distribution, and new service concepts.

In the field of specialized products and highly technological processes, three research priorities have been identified:

- New technologies for the production and processing of functionalized textile materials;
- The development of textiles from renewable raw materials;
- Biotechnology in the production and processing of textiles.

With regard to the goal of using new, innovative textile materials (i.e., products), the following three important areas have been emphasized:

- New textile materials for personal protection (medicine, protection, sports etc.);
- New textile materials for technical use (transport, construction, geotextiles etc.);
- Smart textiles and clothing.

In the transition from mass production to customization, the following key research areas have been determined:

- Tailor-made customization;
- New designs and concepts for product development and technologies.

Performing this suggested research will generate market innovation if the fields can connect on various joint projects, which will combine the knowledge from the fields of materials, technologies and marketing approaches and promote cooperation in the chain of values.

The STTP is a neutral mechanism. It operates on principles of openness and transparency in accordance with the operating guidelines of the European technological platform for the future of the textile and clothing industry and in accordance with the aims and needs of the Slovene textile and clothing industry. The STTP does not choose projects, but it provides a strategic framework of research and creates conditions for forming projects with effective realization at the national and international level.

Performance of the strategic research agenda is foreseen for 2007–2013 in the form of R & D projects. The STTP partners will collaborate on these projects to provide the resources for research and activity performance. Special attention will be directed toward acquisition of funds in the framework of national R & D programs, such as the 7th frame program of the European Commission, Eureka, and many other state and regional program schemes. The STTP will mediate information on priorities and textile technological platform plans to actors of the public sphere, which will help decide R & D programs and, in this way, try to enable equal conditions for innovations in the textile and clothing industry, as other industrial sectors do. Through participation in the textile technological platform network, interested partners will, regarding interests and compatibility of aims, include in other R & D consortiums at the Slovene and European level.

The STTP will, during the phase of implementation of the research agenda, create suitable conditions for modeling of projects. Activities will include organization of meetings, encouraging communication at the national and international level, collection and mediation of information on European and national programs, following the progress of projects, and providing information of interest to the public on the research results. International summer STTP conferences, seminars, workshops, and so on will be provided. An important role of the STTP is strengthening the consciousness of developmental abilities for the textile and clothing industry because only self-confident managers, owners, researchers, and scientists can be open to a future with developmental breakthroughs. Therefore, an important variable will be positive communication and the role of innovativeness in sustainable development of the textile and clothing industry [13, 14].

CONCLUSIONS

Strategic direction of Slovene textile and clothing industry is in development of topmost innovative textile products and services which demand high technologies and which are mastered by highly educated experts. Successful getting on in the new geographic and product markets is planned in research which will lead to development of textiles with new or essentially improved properties, to development of textiles with planned functionality for special fields of use and to development of systems which will enable cost effectiveness, higher level of personalisation, greater functionality and differentiation.

In the future, the textile and clothing industry will be able to survive and operate successfully only if it changes business policy. The business policy must be more interested in demand, more flexible – to adapt to possible changes that have occurred, to respond to specific needs and requirements, to allow easy and rapid re-orientation between the types of production, and also to monitor new technology, management and other innovations [11].

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Curriculum and cybernetic modeling of planning and realisation related to teaching in textile subjects

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REZUMAT – ABSTRACT

Curriculum şi modelarea cibernetică a planificării în procesul de predare a subiectelor axate pe domeniul textil

Studiind posibilităţile de implementare a ciberneticii în pedagogie, autorii au ajuns la concluzia că componentele curriculumului academic sunt compatibile cu subsistemele şi elementele de bază ale managementului sistemelor cibernetice. Acest fapt poate fi observat, în special, în modelarea cibernetică a ciclurilor şi ariilor curriculare integrate în planificarea predării. Cea de-a doua parte a lucrării abordează posibilităţile de planificare a predării în conformitate cu metodologia curriculumului, toate acestea fiind demonstrate experimental pe o tematică din domeniul textil. Cea de-a treia parte a lucrării, care este considerată cea mai importantă, abordează activităţile (etapele) managementului didactic, utilizate în planificarea şi atingerea obiectivelor procesului de predare. Astfel, autorii consideră că planificarea procesului de predare utilizând algoritmi ai activităţilor manageriale în sistem cibernetic, care se bazează pe curriculum, vor crea oportunităţi pentru reglementarea şi evaluarea mai obiectivă a procesului de predare, benefice în raţionalizarea şi eficientizarea acestuia.

Cuvinte-cheie: materiale textile, curriculum, modelare cibernetică, planificarea procesului de predare

Curriculum and cybernetic modeling of planning and realisation of teaching textile subjects

Having studied possibilities for implementation of cybernetic in pedagogy, the authors have come to the conclusion that the components of academic curriculum are compatible with basic sub-systems and elements of management in cybernetic systems. It can be seen especially in the model of cybernetic regulation circle with integrated curriculum and input order for teaching planning. The second part of this paper deals with possibilities for teaching planning according to curriculum methodology, and all these have been shown experimentally in textile subjects. The third part of this paper, which is considered as the most important, deals with didactical management actions (steps) that can be used for managing planning and realisation of teaching goals. Thus, the authors think that planning of teaching process using algorithm managing actions in cybernetic systems, which are based on curriculum, would make opportunities for regulation and more objective evaluation of teaching process, which would be beneficial for rationalization and efficiency of teaching process itself.

Key-words: textile, curriculum, cybernetic modeling, planning of teaching process

Planning and programming of teaching process by academic curriculum method is, more or less, well known in all school systems in the world. On the contrary to traditional planning, which has been related to content of teaching, this concept respects all teaching components including conditions, didactic triangle as well as course of teaching, its organization and evaluation.

Curriculum gives priority to goals and effects of teaching process. Effects (expected achievements) are the results of teaching process and they define knowledge, skills, movements and values that should be adopted and developed by the student. These effects are produced from defined goals and they usually represent their concretization. Depending on them, other key elements of teaching process are defined: contents, strategies-methods, media, workforms and even the didactical role of students and teachers.

In our previous works we have identified basic structural components of curriculum [1]:

- assumptions about student and teacher;
- goals and effects;
- thematic units and contents;
- basic concepts, activity of students and teachers;
- teaching methods;
- workforms in teaching;
- evaluation.

Some basic sub-systems and elements of managing in cybernetic systems have also been defined (fig. 1). The cybernetic managing system includes input value, two sub-systems (managing and managed), managing actions, disturbances, output values/effects and feedback that acts as a correction.

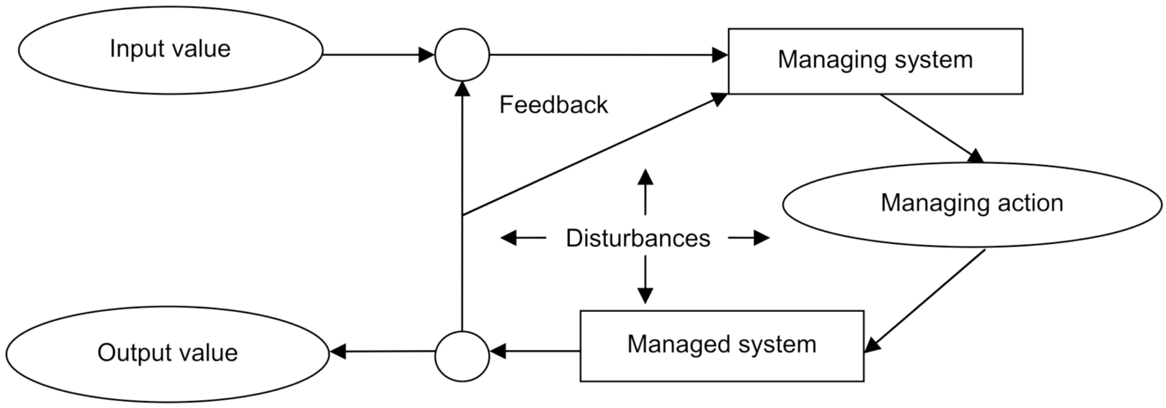

Fig. 1. Basic sub-systems and elements of managing in cybernetic systems

COMPATIBILTY OF CURRICULUM AND ELEMENTS OF CYBERNETIC SYSTEMS

On the basic of the graphic, it is obvious that the curriculum components are compatibile with sub-systems and elements of cybernetic system. Compatibility is obvious either in its structure or in function dynamics. It can be clearly seen in an example of teaching model in a shape of cybernetic regulation cyrcle, when the input order is given. Planning in teaching (fig. 2).

During planning of teaching process and realization of curriculum in one school year, which is modelled in cybernetic regulation circle, the Managing system includes teaches, the principal, educational-psychological service, professional bodies of school etc. (Regulators).

The students are part of Managed system (Regulated part) i.e. the one which is being regulated. Managing system elects managing actions in order to improve teaching process on the basis of defined curriculum, which determine goals and appropriate values i.e. effects (Input-Output). Managing is being carried out according to didactical reguirements related to planning of teaching process on the basis of common principles of teaching, choice of sample contents, optimal strategies and methods, media and teaching workforms in appropriate organization of teaching.

So, the main goal is to achieve desired values in order to change the structure of students` psychological dispositions. Both systems are subjected to constraints, which should be taken into consideration. Regulation and correction in the model are achieved through feedback and the effects of planning are being evaluated. Depending on achieved effects, the Managing system is trying to find better solutions in order to improve the quality of teaching. First of all, however, it is necessary to define curriculum for a school subject. The authors have chosen to make a curriculum for the subject Textile testing, IV grade of secondary school for textile with the following number of classes: theoretical classes, two classes a week (60 classes per year) and experimental classes, three times a week (90 classes per year) [2]. As the program is too extensive, individual examples have been given for stated components of curriculum. It is very important to notice that sullabi in textile is very suitable for making curriculum. The goals and effects are easy to define, the content is exact and and appropriate, especially for the usage of algorithm strategy, both in theoretical and experimental part of teaching process.

THE MODEL OF CURRICULUM FOR THE SUBJECT TEXTILE TESTING

Assumptions

Assumptions on conditions:

- appliances for sorting bundles of fibers in a certain length;
- appliances and instruments for testing length, count and fiber curl;
- appliances and instruments for yarn testing (dynamometer, torsiometer etc.).

The assumptions have been made on the basis of the content reffering to this subject.

Assumptions on student:

- knowledge, skills, motives, interests and values that are important for overcoming difficulties of teaching in this subject;
- capability for participation in the chioce of goals and teaching process` methods, as well as the capability of validation of its own work and the work of his associates.

Assumptions on teacher:

- professional, educatinal-psychological qualifications of teachers;
- ability to motivate and define social interaction between students;
- ability to evaluate its own work and students` work.

Assumptions on teachers and students are defined by knowledge tests, ability and personality tests and can be stored in database of IT center in the school.

Aims and goals

- Students have to adopt basic knowledge about textile material testing in order to determine its quality and to detect any mistakes made during the production.
- Adopting tehniques for handling instruments, aparatus and machines and defining different influences and characteristics of textile materials.

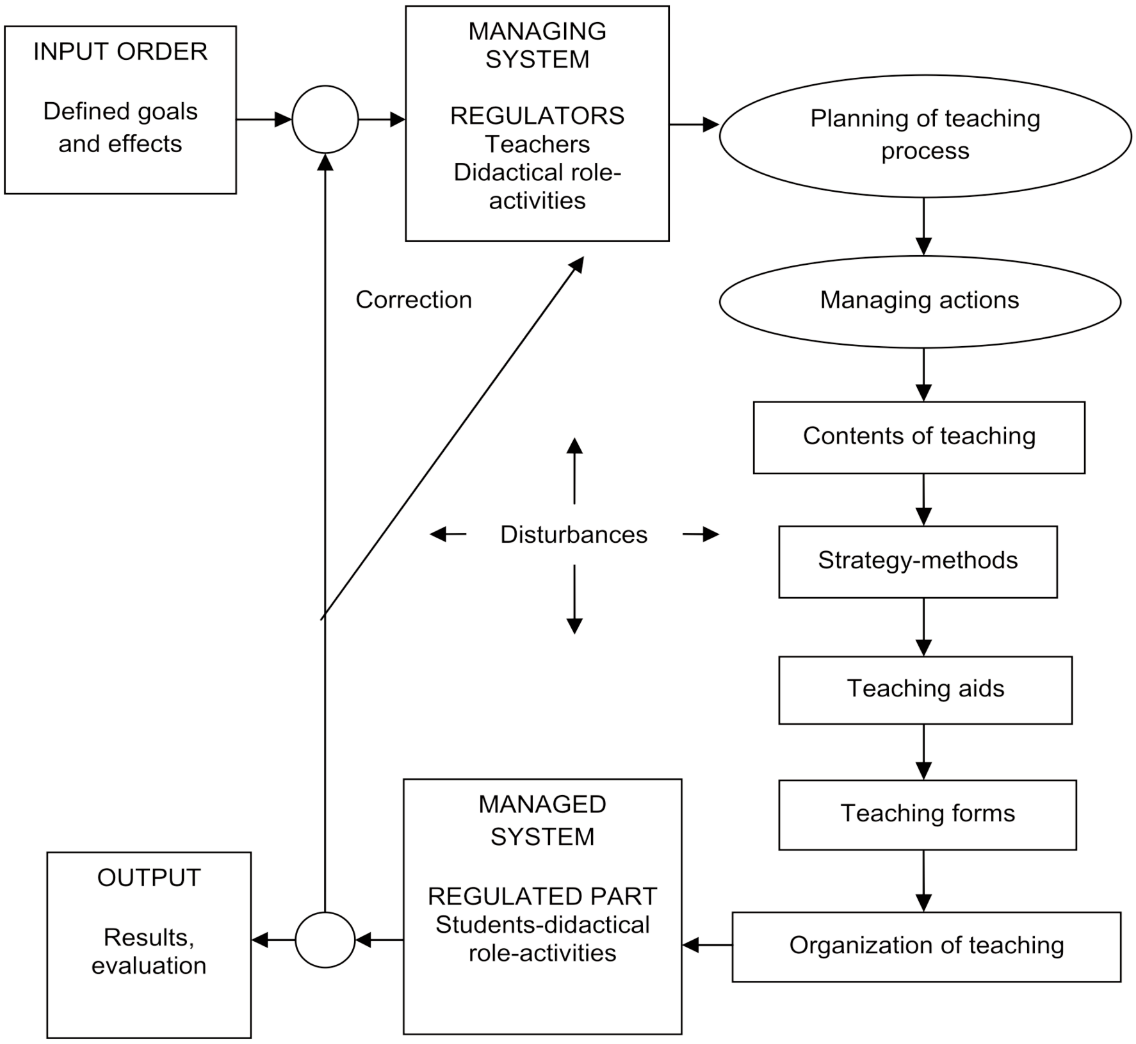

Fig. 2. Cybernetic modle of planning of teaching process according to curriculum methodology

Effects obtained

- After finishing IV grade, the students will be able to understand methods and tehniques of textile material testing;
- The students will be able to handle instruments, aparatus and machines for textile material testing;
- The will get to know methods of presentation and processing of research results with the usage of standards.

Aims and effects should include all three branches of study: cognitive, affective and sensorimotor learning.

Thematic units and contents

The programm could be carried out through 5 themes including:

- General part;
- Microscopic research;
- Physical research;
- Chemical research;
- Other researches (biological, laser and rendgen).

Experimental part includes:

- General part (determining humidity and moisture);
- Fibre testing;
- Semi product testing;
- Final product testing.

Concepts includes:

- Types and methods of testing, standards, basic concepts of statistics, types and measuring of humidity, textile materila characteristics;
- Microscopic, physical, chemical and other testings.

Activity of students

- Activity during the realization of experimental part
- Solving mathematical tasks. The students make conclusions about the influence of technological process on the characteristis of the products.

Activity of teachers

- Choose appropriate number of exercises and participate in their realization;
- Take care of accuracy and speed of carrying out experiments.

Teaching methods

- Verbal-textual, illustrative-demonstrative, laboratorial-experimental, practical work methods.

Teaching concepts

- Individual work, pair work, group work, frontal work.

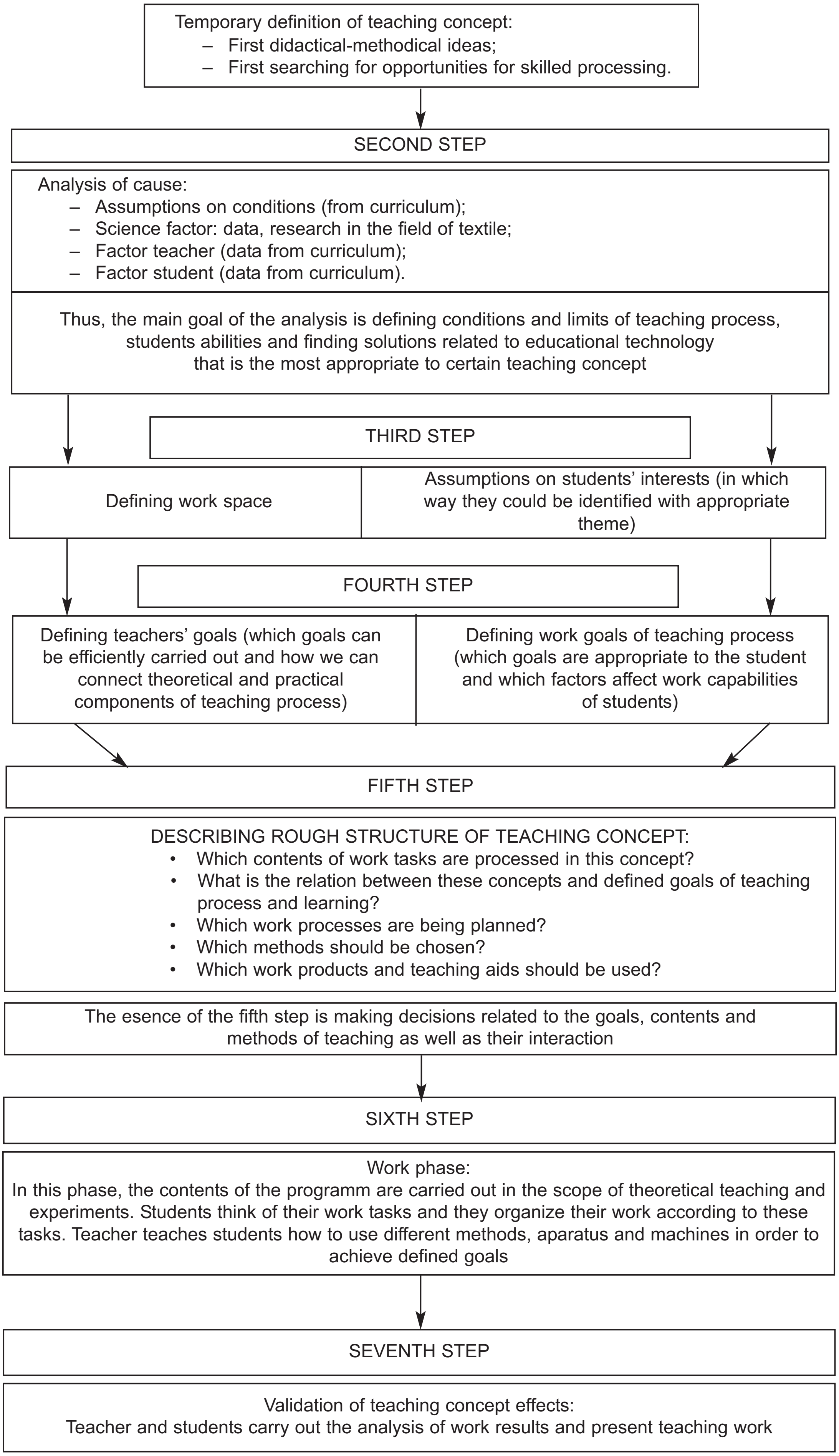

Fig. 3. Key managing steps, which have dominant role in plannig and realization of teaching process

Evaluation

- Knowledge, ability and pesonality tests;
- Oral and practical examination.

MANAGING TEACHING PLANNING

However, the main goal of this paper is to show that cybernetic regulation circle can be used for direct managing of managing actions related to teaching planning and realization of its goals.

It can be sucessfully carried out by algorithm managing steps of appropriate phases in teaching planning. These steps are shown in German didactical literature issues [3], but the authors have integrated them into a cybernetic model and supplement and modify according to the characteristics of teaching process related to textile subjects.

Thus, according to the authors, the managing process could be carried out through seven key managing stetps, which have dominant part in planning and realization of teaching process, and which are also crucial for improvement of teaching quality in certain thematic concepts and contents (fig. 3).

CONCLUSIONS

Conclusion considerations of this paper deal with two main problems:

– What are the advantages of academic curriculum, which is modelled in cybernetic regulation circle, for the improvement of efficiency of teaching process?

– What are the obstacles and limitations of this concept?

Firstly, instead of evident improvisations in realization of teaching goals, it has been possible to manage teaching process. It means that according to input value order (what should be done) through managing program, we can directly affect accomplishing desired values. By relationship between defined and obtained goals, it can be efficiently defined level of managing efficiency and curriculum.

System analysis is used to define connections and relationships between curriculum components, like the relationship between goals and concepts of teaching process, and it can be evaluated whether the contents in the function of accomplishing those goals. What`s the relation between teacher and student, student and teaching aids, are the students capable to achieve defined goals? Relationships between elements of one component can be defined such as relationships of thematic concepts within teaching contents. The analysis can be used for evaluation effects of individual managing actions and programmes in general. There is a possibility to measure mutual effects of individual curriculum components.

Limitations related to this concept are related to the complexity and applicability of teaching systems. Therefore, there are many questions such as how to manage and measure effects of pedagogical process in teaching. Managing teaching process is still at the beginning. Conditions and mechanisms of managing process are still not familiar enough. We often pay attention to managing mechanism instead of pedagogical dimension of teaching process.

However, thanks to IT technologies, it is possible to measure and evaluate effects of curriculum in cybernetic models. We are now ready to model, cybernetize and mathematicaly analyse in teaching systems. Objective measurements of these effects should be of great importance for all schools because it is evident that they are, nowadays, concealed and underestimated. It is also very important that, in this way, schools could be funded accordinggly to obtaine results, which is desirable in all educational systems.

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An econometric estimation of the wage determinants in the light industry

MIHAELA DOBRE CRISTINA VIŞAN

REZUMAT – ABSTRACT

Analiza econometrică a determinanților salariului în industria uşoară

Lucrarea are la bază o serie de controverse privind consistența corelației dintre nivelul salariului şi cel al productivității muncii. Chiar dacă teoria economică postulează că cele două variabile trebuie să fie puternic corelate, analizele empirice par să contrazică acest postulat. Cauzele invocate sunt multiple, pornind de la raportul de forțe în negocierile dintre patronate şi sindicate, imigrația, concurența acerbă pe plan mondial, practicile de dumping ale unor exportatori, până la inovațiile tehnologice etc. Scopul acestei cercetări constă în evidențierea semnificației factorilor de care angajatorii țin cont în stabilirea salariului acordat lucrătorilor. Rezultatele cercetării au arătat că salariul este influențat, în cea mai mare măsură, de prețurile bunurilor de desfacere şi mai puțin de productivitate, respectiv de cifra de afaceri, confirmând astfel curentul de opinie care pune la îndoială soliditatea corelației dintre salariu şi productivitatea muncii.

Cuvinte-cheie: industrie textilă, salariu nominal, productivitate, prețuri, cifră de afaceri

An econometric estimation of the wage determinants in the light industry

This paper is based on a series of controversies as to consistency of the correlation between the level of the wage and that of labour yield. Even though the economical theory postulates that the two variables have to be closely correlated, the empirical analyses seem to contradict this postulate. The pleaded causes are multiple, such as the forces ratio within the negotiations between the employers and the trade unions, immigration, the tough competition worldwide, certain exporters' dumping practices, the technological innovations etc. The goal of this research consists in outlining the significance of the factors that employers take into account upon setting up the wage granted to labourers. The outcomes of the research have shown that wage is the most influenced by the selling goods prices and less by yield and by the turnover, thus confirming the opinion trend that calls into question the solidity of the wage-labour yield correlation.

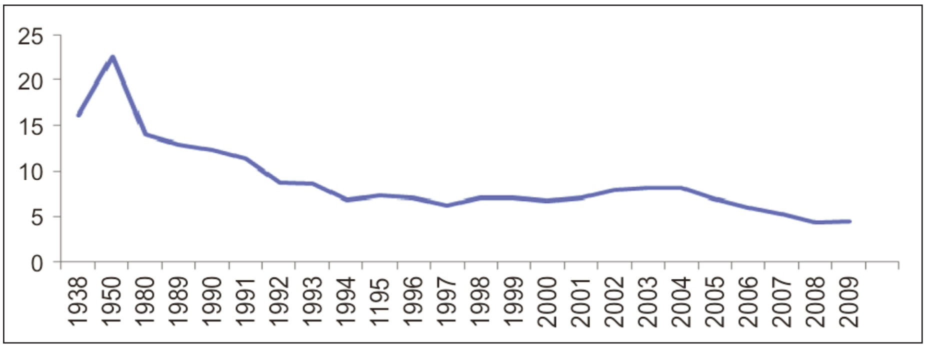
Key-words: textile industry, nominal wage, productivity, prices, turnover

In the past few years, globalisation has very much influenced the light industry, as the great producers have shifted their manufacturing premises to countries under development, where the legislative and social framework, the environmental protection norms and the wages level shape favourable conditions for low production costs. The Asian countries have taken benefit the most from this context, inducing bankruptcy to many producers from the developed countries. Romania is among the states that these past years has seen a reduction of the economical activity in the light industry, this latter's ratio within the whole industry decreasing to less than half in the past two decades (fig. 1).

One can notice that the light industry ratio has decreased from a peak of nearly 25% in 1950 to approximately half (12.5%) towards the end of the 80s, reducing itself to a half once more starting from 2007 (less than 5%), against the background of a dramatic reduction of the industrial activities in Romania. On analysing the light industry on sub-fields, one notices that the textile sector has the most pronounced activity reduction: from a peak of 11.1% of the total industrial production in 1950, in 2009 it came to 1% (fig. 2). The ready-made clothes sector sees a slight retrieval after 1997 (when it records 2.4% from the total value of the industrial production), reaching 4% in 2004 and beginning with 2005, this sector sees a continuous drop till 2009 (2.9%).

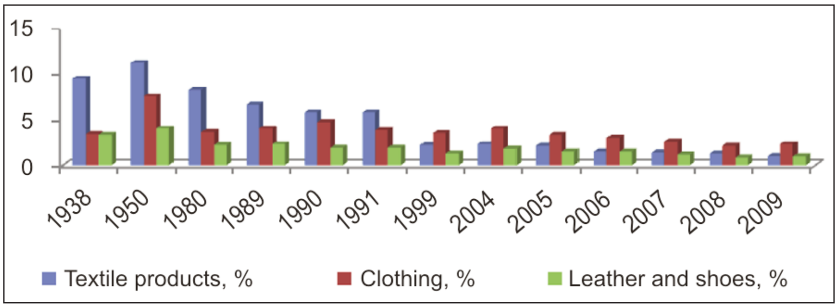
The industrial production from the leather goods and footwear sector has got an evolution similar to the foregoing, by a reduction to half between 1990 and 2009.

The production diminishment after 1990 in the light industry was accompanied by a reduction of the number of employees and the only sector of activity having recorded an enhancement of the employment level between 1997 and 2003 was the clothing sector (fig. 3).



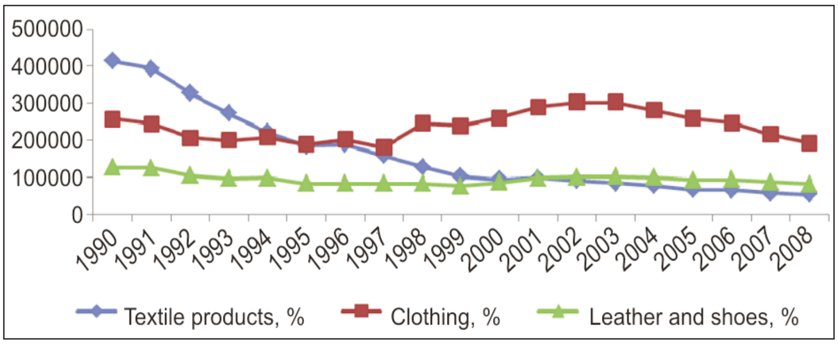
Source: National Statistics Institute

Fig. 1. The light industry evolution as a percentage of the total industry production



Source: National Statistics Institute

Fig. 2. The evolution of the three branches of the light industry as a percentage of the total production



Source: National Statistics Institute

Fig. 3. The evolution of the employees

The decline of the Romanian light industry has also reflected itself in the exports dynamics. Thus, after a peak of 32.68 % from the exports totality in 2000, the contribution of the light industry to Romania's external exchanges came back in 2010 to a level close to 1991 (12.17% as compared to 12.09%) and the CIF imports in the light industry between 1991 and 2010 increased by 3.63% (fig. 4), even though at the world level textile & footwear trade has increased by more than 100 times in the past 45 years [1].

Despite the decline of the three sub-branches of the light industry, at Romania's level one has noticed a trend of enhancement of the wage gain, which has caused us to study the determinants of the wage dynamics. According to the economical theory, the wage that an employee receives must be equal to labour yield, meaning that the competitive companies should hire manpower till the point where their marginal yield equals the wages level.

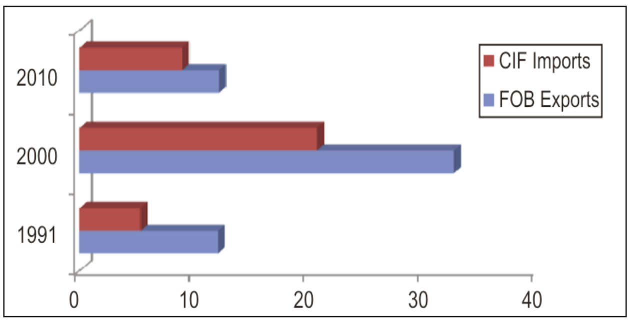
Bruce (www.economica.ca) [2] tested on the Canadian labour market the hypothesis according to which an increase of labour productivity by a certain rate will bring along wage increase by the same rate. Yield increase leads to the life standards enhancement and the other way round (Cashell, 2004) [3], however the modification of the real wage is not fully explained by the labour productivity modification.

Greenhouse and Leohardt (2006) [4] showed that the trade unions no longer had the ability of negotiating considerably high wages, beyond labour yield, and that a labour yield increase (measured as a value of the hourly production) led to the decrease of real wage in the U.S.

Sachdev (2007) [5] analyses the relationship between wage and productivity after applying various deflators to the nominal wage, by using quarterly data from the American economy. A testing of this correlation supposes the utilisation of the simple regression and of the lags regression and it includes two periods of time (1960–1979 and 1980–2005, respectively) for checking the stability of the connection between the two variables. The results of the simple regression show a stronger tie for the former period of time (the coefficient equalling 1.2), as compared to the latter lapse of time (where the coefficient is 0.69). The lags regression shows that the influence of yield upon real wage writes off in time.

Magda, Rycx (2008) [6] carried out a study where they analysed the factors that influence the wage differences between the East-European countries' (Latvia, Lithuania, the Czech Republic, Poland and Slovakia) industries and the West-European ones' (Belgium, Italy, The Netherlands, Norway, Portugal and Spain). The study shows that there are big wage discrepancies amongst the sectors, but also countless similitudes between the East-European countries and the West-European ones. In the energy, IT, chemical and financial industry, the wages are higher and at the opposite we find such traditional sectors as wood, textiles, ready-made clothing and leather items, hotels and restaurants.

Mourji and Bousselhami (http://www.ps2d.net/media/fouzi_mourji.pdf) [7] analysed the influence of minimal wage on labour productivity in Morocco. First of all they measured the impact of the minimal wage on the medium wage, then they analysed its influence on labour yield in the manufacturing industry. The empirical outcomes proved that minimal wage was likely to influence medium wage at the level of a company, which, in its turn, influenced labour productivity. This



Source: National Statistics Institute

Fig. 4. The evolution of the external trade in the light industry (% of the total trade)

was also demonstrated by Ailenei et all. (2010) [8] on the labour market in Romania.

THE RESEARCH METHODOLOGY

The authors used the research methodology from the study performed by Sachdev (2007), which identified the factors that influence nominal wage and they adapted this template on Romania's case. The factors that influence the wage level act with a certain difference, which is mostly due to the employers that are not able to rapidly adapt themselves to the changes that occur in the business environment. That is the reason why, according to the correlation matrix (between the dependent variable and the independent variables), one has set up the lags that are the most relevant for the econometric template used, which can generally be put down in the following manner:

$$y_t = a_0 + a_{11} \cdot y_{t-1} + ... + a_{1k} \cdot y_{t-k} + a_{21} \cdot x_{2t} + ... + a_{2v} \cdot x_{2t-v} + ... + a_{31} \cdot x_{3t} + ... + a_{3n} \cdot x_{3t-n} + a_{41} \cdot x_{4t} + ... + a_{4z} \cdot x_{4t-z} + \varepsilon_t$$

where:

t is the number of observations;

k – the number of lags of the dependent variable;

ε_t – the standard error, which is supposed to have the 0 average and a constant dispersion;

v, n, z – the number of lags of the explanatory variables.

Within this study we estimated wage equations for the three branches of the light industry: textiles, clothing and leather tanning and finishing; travelling, Morocco, harness and footwear items manufacture; fur preparation and dyeing. In order to analyse the correlations between the variables we used data with a monthly frequency (March 2000 – December 2010), which had been taken from the National Statistics Institute (tempo online). For each branch of activity we used the variables from table 1, calculated as chain-based indices.

The data series were deseasonalised by means of the Census-X12 function and their stationarity was checked up by the ADF (Augmented Dickey Fuller) test, the results thereof being positive.

THE EMPIRICAL ANALYSIS

Within this study we tested several exogenous variables, for several lags, and we selected the most relevant ones from the econometric point of view.

The textile industry

For the textile industry we obtained the following regression equation (1):

$$SALT\_V = \underset{(3.18)}{67.71} - \underset{(-2.47)}{0.21} \cdot SALT\_V(-1) + \underset{(2.05)}{0.05} \cdot WT\_V(-3) + \underset{(3.74)}{0.09} \cdot CATI\_V + \underset{(2.07)}{0.4} \cdot IPPT\_V\_INT \quad (1)$$

The wage in this sector of activity has had an oscillating trend, without however being strongly inertial, and the negative coefficient associated to lag 1 indicates a process of correction at its level during the current period of time. Temporally speaking, labour yield is a leading variable, in the sense that it brings forth corrections three months before the current period of time. In terms of economy, this situation can be accounted for from the standpoint of Keynes' theory, according to which wage remains constant between two negotiations, irrespective of the labour yield evolution. It is specifically for this reason that the influence of this variable is weak (the coefficient is 0.05), only the positive sign, consistent with the economical theory, being of note.

The turnover on the domestic market is positively correlated to the wage level, having a higher impact than the labour yield one, and it is obvious in the current period of time, which means that at a 1% increase of the turnover index, the wage will rise up by 0.09%. The highest impact on the nominal wage index comes from the selling goods prices index, so that at a 1% increase of these prices, the medium nominal wage will rise up by 0.4% because of the inflationist pressures in terms of offers.

Seeing the high weight of the lohn production within the total production, we replaced the domestic turnover by the one obtained from the external market and we estimated the following equation (2):

$$SALT\_V = \underset{(6.46)}{90.06} - \underset{(-2.98)}{0.25} \cdot SALT\_V(-1) + \underset{(2.04)}{0.04} \cdot WT\_V(-3) + \underset{(3.66)}{0.07} \cdot CATI\_(EXT\_V) + \underset{(2.06)}{0.24} \cdot IPPT\_V\_EXT \quad (2)$$

Table 1

MODELS VARIABLES	
Variable	**Significance**
SALT_V; SALI_V; SALP_V	Average monthly net earning index of textiles, clothing and leather
WT_V; WI_V; WP_V	Work productivity index in the textile, clothing and leather industry (calculated as the ratio of production index and the index number of employees)
IPPT_V_INT; IPPI_V_INT; IPPP_V_INT	Price indices of industrial production for the domestic textile, clothing and leather markets
IPPT_V_EXT; IPPI_V_EXT; IPPP_V_EXT	Price indices of industrial production for the external textile, clothing and leather markets
CATI_V; CAI_V; CAP_V	Indices of turnover on the domestic market for textiles, clothing and leather
CATI_EXT_V;CAI_V_EXT; CAP_V_EXT	Indices of turnover on the external market for textiles, clothing and leather

The influence of the turnover made by exports on the nominal wage is lower than the turnover obtained from the domestic market, on account of the low level of the manpower's cost in Romania as compared to the European Union's countries. On the other hand, the estimates obtained support the hypothesis of a detrimental distribution, in Romania, of the added value in the textile industry, because its largest part rests with the foreign companies. Furthermore, the distribution of the influence of the other factors on the nominal wage changes:

- the self-regressive component of the wage, as well as its self-correction increases;
- the impact of labour yield on the nominal wage decreases;
- the influence of the external prices index as compared to the one of the domestic market prices index is lower and this phenomenon can be explained by the narrower prices variation margin on the external market (where the competition is tougher) and by the dominance of the lohn system in the textile industry.

The clothing industry

As regards this field of activity, the following nominal wage regression equation was selected (3):

$$\underset{(2.38)}{SALI\_V = 35.53} - \underset{(1.79)}{0.13 \cdot SALI\_V(-6)} + \underset{(5.15)}{0.18 \cdot WI\_V} + \underset{(2.07)}{0.28 \cdot IPPI\_V\_INT(-1)} + \underset{(1.80)}{0.04 \cdot CAI\_V} \qquad (3)$$

In case of this sector of activity, the self-regressive contribution of the wage is lower (than in case of the textiles), but positive and distributed on a farther lag (6), which means that the wage in this field of activity is more rigid. The impact of labour yield on wage is more significant for this sector if activity (the coefficient is 0.18), because of the higher level of qualification of manpower, and the adjustment is more rapid. The influence of the turnover is also maintained at a low level and the impact of the clothing products' selling prices is lesser than in case of the textile products prices (0.28 as compared to 0.4). The phenomenon can be accounted for by the fact that the clothing prices variation margin is lower than in case of textiles, given the tough competition in the imports field.
If we take into consideration the external turnover instead of the domestic one, the equation of the nominal wage may be assessed in the following way (4):

$$\underset{(2.92)}{SALI\_V = 45.28} + \underset{(1.48)}{0.11 \cdot SALI\_V(-6)} + \underset{(3.33)}{0.14 \cdot WI\_V} + \underset{(1.67)}{0.25 \cdot IPPI\_V\_EXT(-3)} + \underset{(2.27)}{0.04 \cdot CAI\_V\_EXT} \qquad (4)$$

The impact of the turnover from the external market on nominal wage is weaker than in case of the domestic turnover, for reasons similar to the situation existing in the textile industry. In addition, the influences of all the other factors are also more reduced, which indicates a tougher competition environment than the one noticed on the internal market. What is more, the coefficient associated to the self-regressive component of the wage is at the limit of the significance student's t-test (with an 86 % acceptance probability).

Leather tanning and finishing, travelling, Morocco, harness and footwear items manufacture for preparation and dyeing

For this field of activity we estimated the following econometry equation of the nominal wage (5):

$$\underset{(4.63)}{SALP\_V = 89.02} - \underset{(-2.67)}{0.23 \cdot SALP\_V(-1)} - \underset{(-1.53)}{0.06 \cdot WP\_V(-10)} + \underset{(2.56)}{0.44 \cdot IPPP\_(V\_INT)} - \underset{(-1.48)}{0.02 \cdot CAP\_V(-1)} \qquad (5)$$

On analysing the leather goods sector, one can notice a wage dynamics similar to the one from the textiles sector, in the sense that we come back to the lag 1 correction, but with a higher coefficient (–0.23 as compared to –0.21 for textiles). The influence of the selling prices is slightly higher (0.44 as compared to 0.40) and the coefficients corresponding to labour yield and to the turnover are econometrically relevant (the student's t-test being underneath the significance threshold).
If we take into account **the turnover on the external market**, the equation above can be re-written as follows (6):

$$\underset{(5.55)}{SALP\_V = 85.05} - \underset{(-2.51)}{0.21 \cdot SALP\_V(-1)} + \underset{(1.43)}{0.05 \cdot WP\_V(-6)} + \underset{(1.73)}{0.2 \cdot IPPP\_(V\_EXT)} + \underset{(3.58)}{0.11 \cdot CAP\_V\_EXT} \qquad (6)$$

On the external market, the turnover has an important influence on the nominal wage, with a very good significance threshold, but the impact of the selling prices index drops at half. Moreover, the influence of labour yield gets reduced by half, tending to decrease under the significance threshold of the normality test, which shows that the added value created by the leather, Morocco and footwear industry on the external market is low.

CONCLUSIONS

The option for the research field of the correlation between the wage level and labour yield is related to the fact that the textile, ready-made clothes, leather and footwear industries represent activities with a long tradition in Romania's modern economy.
Thus, in the communist period, these activities were supporting an important part of the Romanian exports both in the CMEA (The Council for Mutual Economic Assistance) area and in the developed capitalist countries. But after 1990 these activities had a real collapse because of certain inefficient privatisations, of sometimes questionable bankruptcies and of the dumping competition of the Asian producers (form China and especially India). The slight sudden change for the better in the past few years (prior to the world economical crisis) was greatly based on the lohn system, by the attraction of strong European

producers that were interested in the manpower's low cost and in the geographical proximity.
The nominal wage in the textile sector is influenced the most by the index of the selling goods prices, both on the domestic market and on the external one. The results obtained contradict the basic hypothesis of the economical theory as to the strong positive connection between the wage level and the labour yield one. Thus, the econometric equations corresponding to the textile and leather tanning and finishing; travelling, Morocco, harness and footwear items manufacture ; fur preparation and dyeing industries have labour yield coefficients with modest values (0.04 – 0.06), except for the clothing industry (where the coefficients range between 0.14 and 0.18). Interestingly, the distribution of the lags associated to labour productivity reveals one month, three month or even 10 month delays. The explanation could be related both to the specificity of the cycles for manufacturing and selling the products made (especially on the external markets) and to the modest contribution of the creativity of the human capital working in the industries under analysis, because of the lohn system dominance.
As concerns the influence of the turnover, even though its influence on wage is weak, there are important nuances amongst the three fields of activity analysed: in the textile industry the domestic market influences the wage level more than in the external one (a 0.09 coefficient as compared to 0.07), in the ready-made clothes industry the influence is at the same level (i.e. 0.04) and in the leather goods a.s.o. industry, the impact of the external markets is far greater (0.11 as compared to 0.02). This situation may be accounted for by different competition relations between the domestic market and the external one in the three sectors of the light industry, but also by different contributions of the gross added value reached in the textile industry as compared to the leather products industry.
In all the three fields of activity, the prices index of the goods made plays an important part in explaining the nominal wage dynamics. The strongest correlation is recorded in case of the leather products industry for the domestic market, due to the appreciation of the quality of the materials used vs. their substitutes and the workmanship. But the influence of the export prices on wage is abruptly reduced (0.2 as compared to 0.44) because of the tough competition and of the lohn production system dominance. This situation is almost similar in case of the textile industry (a 0.4 coefficient for the domestic market and 0.2 for the external one), however the differences are minor in case of the ready-made clothes (a 0.28 coefficient corresponding to the domestic market, as compared to the 0.25 one for the external one).
The results obtained on the basis of the three equations highlight the importance of the prices in the wage-related decisions and less the information regarding labour yield and the turnover, respectively. The circumstantial factors, the reduced contribution to the gross added value reached in Romania by the three industries under analysis and the inefficient valorisation of the autochthonous manpower's potential represent weaknesses of the new profile of the last decades' Romanian profile.
On the external market, the turnover has an important influence on the nominal wage, with a very good significance threshold, but the impact of the selling prices index drops at half. Additionally, the influence of labour yield is also reduced to half, tending to decrease under the significance threshold of the normality test, which indicates that the added value created in the leather, Morocco and footwear industry on the external market is low.

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Materii prime

O NOUĂ GAMĂ DE NANOFIBRE ARAMIDICE

Compania ***Teijin Techno Products*** a dezvoltat primele nanofibre aramidice, cu proprietăți calitative superioare şi cu o rezistență ridicată la căldură şi oxidare, având aplicabilitate la scară industrială.
Nanofibrele cu dimensiuni uniforme şi cu un diametru de doar câteva sute de nanometri sunt obținute din fibre metaaramidice rezistente la căldură, *Teijinconex*. Ele urmează a fi utilizare ca materiale nețesute destinate separatoarelor bateriilor cu ioni de litiu, fiind lansate pe piață începând cu anul 2014.
Până în prezent, nanofibrele aramidice au fost produse doar la scară de laborator, iar realizarea acestor produse la scară industrială reprezintă un adevărat progres. Nețesutele din nanofibre aramidice sunt extrem de rezistente la oxidare şi au o rezistență ridicată la căldură, menținându-şi forma până la temperaturi de 300°C. Este de aşteptat ca aceste caracteristici să confere bateriilor cu ioni de litiu, destinate autovehiculelor, proprietăți îmbunătățite de rezistență, putere, capacitate şi densitate energetică, oferindu-le totodată avantaje semnificative față de separatoarele tradiționale, în ceea ce priveşte reducerea riscului de aprindere în aplicațiile de mare capacitate şi densitate energetică ridicată.
Alte caracteristici ale nețesutelor realizate din nanofibre aramidice, utilizate pentru separatoarele bateriilor litiu-ion, includ: porozitatea ridicată – care asigură o mai bună mobilitate a electrolitului, având ca rezultat o putere mai mare şi o încărcare mai rapidă, şi suprafața mărită – care face ca electrolitul să fie eficient şi să mențină performanța bateriei la temperaturi scăzute, atunci când conductivitatea ionică scade. Stratul de nețesute face ca electrolitul să fie absorbit mai rapid decât în cazul separatoarelor tradiționale, realizate pe bază de poliolefine, ceea ce duce la scurtarea timpului necesar turnării electrolitului în baterie şi la reducerea costurilor de producție a bateriilor de mari dimensiuni.
Teijin Techno Products urmează să extindă aplicațiile noului material la separatoarele pentru condensatori, la filtrele de înaltă performanță, rezistente la căldură, şi la detergenții rezistenți la căldură, pentru echipamente de birou.
Grupul Teijin a dezvoltat, de asemenea, două tipuri de separatoare pe bază de peliculă poroasă din polietilenă: unul acoperit cu un compus pe bază de fluor – pentru a conferi o rezistență ridicată la căldură şi aderență la electroliți polimerici, şi celălalt acoperit cu metaaramide Teijinconex, pentru a conferi o rezistență excelentă la căldură şi o bună stabilitate dimensională. Ambele produse vor fi comercializate în cursul acestui an, sub marca Lielsort.

__Smart__textiles and nanotechnology, iunie 2012, p. 5

NOI FIBRE DE LA DYNEEMA

Dyneema a elaborat o nouă fibră *DM20*, destinată producerii frânghiilor rezistente, cu rigiditate şi durabilitate ridicate. *DM20* redefineşte caracteristicile frânghiilor din polietilenă HMWPE, cu masă moleculară mare, elaborate pe baza tehnologiei *Dyneema Max*, dezvoltată pentru producerea cablului de amaraj pentru ape de adâncime. Fiind riguros testate, aceste frânghii sunt ideale pentru aplicațiile care necesită rezistență la solicitări permanente, cum ar fi cele de pe platformele de producere a petrolului şi gazelor.
Lankhorst Ropes, specializată în producerea de parâme pentru ape de adâncime, este prima companie care a utilizat Dyneema Max şi a dezvoltat *Gama 98,* ca o nouă generație de parâme HMWPE, adecvate utilizării permanente în ape a căror adâncime depăşeşte doi metri. Având un diametru mult mai mic decât cel al poliesterului, un grad redus de încrețire, o mare rezistență la oboseală şi o greutate aparentă mică în apă, parâmele produse din noul tip de fibră DM20 oferă utilizatorilor mari beneficii. Ele garantează o rezistență maximă pe parcursul unui ciclu de viață lung, dar şi o manipulare rapidă şi o siguranță sporită, în comparație cu variantele tradiționale, conducând la o eficiență sporită.
În urmă cu peste zece ani, ***DSM*** şi ***Lankhorst*** şi-au reunit eforturile pentru a dezvolta frânghii cu caracteristici tehnice avansate, iar câțiva ani mai târziu au decis să se concentreze asupra sistemelor de parâme utilizate în apele de adâncime. Inițial, companiile au folosit fibra *SK78*, pentru a demonstra beneficiile parâmelor HMWPE utilizate în unitățile mobile de foraj maritim în apele adânci (MODU). În prezent, SK78 este unica fibră HMWPE certificată, pentru a fi utilizată în aplicațiile MODU în apele de adâncime. *Gama 98,* recent elaborată, încorporează DM20, care pare a fi cea mai puternică construcție sintetică de parâme din lume.
DSM a deschis o nouă unitate de producție în Greenville, Carolina de Nord, pentru producerea benzii antiglonț Dyneema.
O exemplificare a soluțiilor furnizate este compozitul unidirecțional *Dyneema HB80* (UD) – unul dintre cele mai performante materialele antiglonț de pe piață. În cursul acestui an, ***Ceradyne*** – un producător de materiale ceramice avansate, a lansat producția noului material *ECH.* Compozitele Dyneema HB80 conferă ECH performanțe excepționale de fragmentare, fără a adăuga un plus de greutate. Banda posedă multe din proprietățile de performanță ale compozitului Dyneema UD, dar şi o mare flexibilitate în proiectarea armăturii, la costuri mai reduse. Domeniile de aplicare cuprind atât protecția corpului, cât şi armături pentru vehicule, de exemplu materialele pentru dezintegrarea proiectilelor, inserții şi armături.

__Smart__textiles and nanotechnology, iunie 2012, p. 7

MAŞINI DE ŢESUT DORNIER

Compania ***Lindauer Dornier GmbH,*** din Lindau – Germania, a participat la Expoziţia internaţională de maşini textile *ITMA Asia* + *CITME 2012*, care s-a desfăşurat în perioada 12 – 16 iunie, la Shanghai, şi s-a axat pe două teme principale: realizări ştiinţifice, soluţii personalizate, textile tehnice şi tehnologii aplicate.
Utilajele prezentate de Dornier – maşinile de ţesut cu graifăr şi maşinile de ţesut cu jet de aer – oferă soluţii optime pentru producţia textilelor tehnice şi a materialelor pentru confecţii, de foarte bună calitate. Inserţia firelor de bătătură slab tensionate face posibilă adăugarea firelor de umplere, care sunt preluate fără atingere şi fără elemente de ghidaj, fiind transmise mai departe şi menţinute în siguranţă prin intermediul capului graifărului controlat direct, până la inserarea în rost deschis. Pe ambele tipuri de maşini de ţesut poate fi fixată o desime a ţesăturii mai mare sau mai mică, în funcţie de necesităţi. Astfel, pot fi obţinute ţesături cu desimi foarte mari, cum sunt cele din aramidă sau benzile transportoare, dar şi ţesături cu desime foarte mică, cum sunt structurile ajurate sau materialele compozite.
Maşina de ţesut cu graifăr P1 PTS 4/S C, cu lăţimea de 220 cm, este destinată producerii textilelor tehnice cu greutate mare, iar maşina de ţesut cu jet de aer A1 AWS 8/S G (fig. 1), cu aceeaşi lăţime de 220 cm, este utilizată pentru producerea ţesăturilor din lână, destinate confecţiilor.

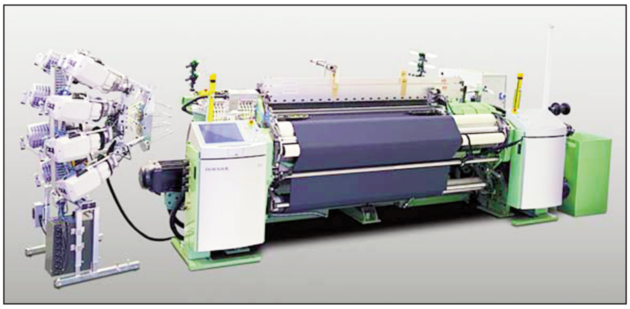

Fig. 1

La standul Stäubli, a fost expusă maşina de ţesut cu graifăr P1 PTS 16/J G, cu lăţimea de 190 cm, destinată producerii ţesăturilor jacard premium, pentru domeniul amenajărilor interioare.
Noul model de motor, *SyncroDrive*, brevetat şi dezvoltat de Dornier, este o componentă importantă a maşinilor de ţesut cu graifăr şi cu jet de aer, de mare viteză. Cu ajutorul acestuia, va deveni mai clară semnificaţia expresiei „weave-by-wire". Conexiunea cardanică între maşinile de ţesut şi sistemul jacard este înlocuită cu un circuit electric de control.

Melliand International, mai 2012, p. 81

O ALTERNATIVĂ AVANTAJOASĂ LA NANOFIBRELE DIN CARBON

Conductive Composites, cu sediul în Heber City – S.U.A., şi-a extins linia de fabricaţie a neţesutelor, ceea a condus la dublarea capacităţii de producţie.
Compania a lansat pe piaţă noi materiale neţesute peliculizate prin depunere chimică din vapori de nichel. Pieţele-ţintă pentru aceste produse includ: ecranarea electromagnetică, conductivitatea încorporată, protecţia împotriva descărcărilor electrice, tratarea suprafeţelor, suprafeţe reflectorizante, izolaţia cablurilor, fibre compozite preimpregnate, filtre, încălzire, stocarea energiei, cataliză.
Materiale neţesute peliculizate prin depunere chimică din vapori de nichel prezintă o serie de avantaje: sunt mai uşoare, mai subţiri şi au o conductibilitate mai bună decât cele realizate din fibre conductoare.
Folosind noua tehnologie, fiecare suprafaţă exterioară este acoperită şi protejată, iar rezistivitatea suportului peliculizat poate avea valori foarte mici. De fapt, se consideră că, dintre soluţiile compozite folosite, aceste materiale au cele mai bune performanţe de ecranare. Caracteristicile de performanţă sunt similare sau chiar mai bune decât cele ale nanomaterialor peliculizate pe bază de carbon şi pot fi realizate sub formă de sul continuu.
Neţesutele cu peliculă continuă pot fi prelucrate în mediu umed, stratul adeziv fiind protejat, iar conductivitatea obţinută nu este prea mult influenţată de grosime.
Substraturile peliculizate includ fibre din carbon, fibre aramidice şi nanomateriale pe bază de carbon, ceea ce determină o conductivitate mai stabilă a materialelor. În plus, prezenţa nichelului conferă rezistenţă la coroziune şi proprietăţi magnetice.
„Ne face plăcere să anunţăm comercializarea acestui nou produs... Neţesutele peliculizate prin depunere chimică din vapori de nichel au avantaje clare în privinţa performanţei şi suntem bucuroşi că putem furniza acest material în cantităţi mari, atât pe pieţele actuale, cât şi pe pieţele în dezvoltare. Noile materiale neţesute permit clienţilor performanţe importante şi reduceri semnificative de costuri. Investiţiile pe care le-am făcut în mărirea capacităţii de producţie şi de comercializare sunt o dovadă a angajamentului nostru de a aduce pe piaţă materiale competitive" – a declarat preşedintele companiei, Nathan Hansen.
Compania Conductive Composites creează materiale şi tehnologii care îmbunătăţesc conductibilitatea electrică şi capacităţile electromagnetice ale compozitelor şi ale materialelor plastice. Materialele sunt fabricate folosind propriile tehnologii, pe linii de producţie conforme cu standardele ISO 9001 ale Organizaţiei Internaţionale de Standardizare.

***Smart**textiles and nanotechnology, mai 2012, p. 6*

Aparate de măsură și control

NOI APARATE DE LABORATOR

Textehno Herbert Stein GmbH & Co. KG Lenzing, din Austria, a lansat în cadrul *ITMA Asia + CITME 2012,* cele mai noi aparate de laborator pentru testarea fibrelor, firelor, țesăturilor şi materialelor nețesute. *Favimat+* combină 6 metode de testare a fibrelor unice într-un singur dispozitiv. Acesta poate fi utilizat pentru testarea unei game variate de fibre, incluzând aramida, UHMPE, sticla şi carbonul. Cu ajutorul unui sistem *Airobot2,* conectat la Favimat+, procesul de testare poate fi complet automatizat. Noul dispozitiv pentru testarea uniformității firelor filamentare *Covavil+,* cu un nou design al senzorului şi un dispozitiv de răsucit fire de mare viteză, îndeplineşte toate cerințele unui sistem de control al calității eficient şi sigur. Utilizat ca unitate individuală sau în combinație cu testerele pentru firele filamentare, *Dynafil ME* şi *Comcount* oferă o foarte mare flexibilitate şi eficiență de testare. Aparatul pentru testarea filamentelor *Dynafil ME* şi-a dovedit eficiența în diverse aplicații, precum testarea forței de tragere a POY, testarea rezistenței la şifonare a DTY şi BCF sau testarea contracției tuturor tipurilor de fire, inclusiv a celor monofilamentare şi ATY.

Textechno a dezvoltat un nou aparat pentru determinarea numărului şi stabilității interțeserilor, *Itemat + TSI*, ca succesor al Itemat, prin Enka tecnica, după preluarea tuturor drepturilor asupra acestui dispozitiv. În timp ce principiul de bază a rămas acelaşi, motoarele şi componentele electronice au fost înlocuite cu o tehnologie de ultimă generație, iar senzorul mecanic de interțesere a fost complet reproiectat, pentru a servi unei game mai largi de densități liniare, la o reproductibilitate mai bună. Ca alternativă la senzorul mecanic pentru fire texturate, este pus la dispoziția utilizatorilor un senzor optic.

Testerul automat *Drapetest,* utilizat pentru măsurarea capacității de drapare a țesăturilor tehnice, permite caracterizarea automată a capacității de drapare şi detectarea apariției defectelor în timpul drapării. Acesta combină măsurarea forței de deformare cu o analiză optică a defectelor de mici dimensiuni, pe bază de imagini. Cu ajutorul unui senzor suplimentar, pot fi analizate defecte mari mari, cum ar fi cutele sau încrețiturile.

Melliand International, mai 2012, nr. 2, p. 105

NOI DISPOZITIVE ŞI MATERIALE DE TESTARE

Compania britanică ***James Heal***, din Halifax, proiectează, dezvoltă şi produce dispozitive şi materiale de testare pentru producătorii de țesături şi confecții şi pentru centrele de testare independente. Ținta vizată este producerea unor dispozitive de înaltă precizie, prin care să se garanteze calitatea materialelor testate.

Titan 4 este o marcă nouă de dinamometru universal, care a fost conceput pentru a testa materiale textile țesute, nețesute şi din piele. Acest dinamometru compact, de tip desktop, operează atât în stare comprimată, cât şi tensionată şi este livrat cu o serie de dispozitive de prindere interschimbabile. Este disponibil cu o varietate de celule de tensionare de până la 3 000 N, care sunt livrate sub formă de cartuş, pentru o mai bună protecție şi pentru a facilita manevrarea şi stocarea în siguranță. Are toate caracteristicile de siguranță specifice unui dinamometru universal, cum ar fi dispozitivele de prindere uşoară, dar este dotat şi cu caracteristici intuitive, concepute pentru a simplifica testarea. Titan 4 lucrează în tandem cu *TestWise 2012,* un software de analiză a testării, care pune la dispoziția clienților un mare volum de standarde internaționale şi naționale, fiind dotat, de asemenea, cu metodele de testare ale comercianților. Disponibil în şapte limbi – engleză, turcă, chineză, germană, spaniolă, italiană şi franceză, TestWise 2012 foloseşte domenii şi terminologie specifică, astfel că rezultatele testelor sunt compatibile cu testul standard folosit.

TruBurst 3 este un aparat de testare a rezistenței la plesnire şi la oboseală. Flexibilitatea inerentă a TruBurst 3 îi conferă capacitatea de a testa o gamă largă de materiale, inclusiv materiale textile țesute şi nețesute, hârtie, materiale plastice şi produse medicale. Metoda de măsurare a dilatării fără contact, cu ajutorul laserului, dă rezultate precise, iar presiunea reglabilă de închidere şi corecția automată a diafragmei previn orice alunecare sau deteriorare a specimenului şi îmbunătățesc precizia. TruBurst 3 este dotat cu un software ciclic intuitiv, ceea ce face ca atât utilizatorii experimentați, cât şi cei neexperimentați să poată folosi cu uşurință cu acest aparat.

Elmatear 2 este un dispozitiv de testare a rezistenței la sfâşiere, puternic şi versatil, care a fost reproiectat, în mare măsură, cu noi caracteristici, conferindu-i un plus de valoare, precizie şi siguranță. Este dotat cu un software prietenos, ce oferă utilizatorilor posibilitatea corectării automate a greşelilor, detectarea automată a greutății pendulului, precum şi indicatori vizuali şi auditivi.

Seria Martindale 900 de aparate de testare a rezistenței la abraziune şi de determinare a pilingului include 3 modele, complet echipate cu 2, 5 sau 9 stații, fiecare reunind cele mai bune caracteristici de aspect, calitate şi funcționalitate. Aparatul de încercare la abraziune Martindale 909 este prevăzut cu 9 stații. Fiecare model oferă utilizatorilor acces facil la toate stațiile de testare.

James Heal produce şi furnizează materiale de testare de referință, de o calitate neegalată, în conformitate cu standarde şi specificații relevante în acest domeniu. Ele sunt produse într-un centru special, dotat cu instalații moderne de urzire, țesere, inspecție, croire şi coasere şi cu aparatură pentru testarea rezistenței fizice, a vopsirii şi pentru analize chimice. Fiecare lot de produse este verificat sistematic în două laboratoare moderne, care se conformează strict, fără compromisuri, la sistemul calităţii. Calitatea şi coerenţa testărilor sunt asigurate, de asemenea, prin agenţii de testare independente, acreditate UKAS, şi prin realizarea unor teste de performanţă alese cu grijă. Compania are toleranţă zero la neconformităţi, iar lansarea unui produs se face doar dacă acesta este în perfectă conformitate cu specificaţiile în vigoare.

Melliand International, mai 2012, p. 88

Confecţii textile

COLDBLACK – O NOUĂ COLECŢIE DE ÎMBRĂCĂMINTE SPORT

Brandul american ***Under Armour***, în colaborare cu companiile ***Clariant*** şi ***Schoeller***, a lansat, în martie 2012, ultima sa colecţie de îmbrăcăminte sport de înaltă performanţă, *Coldblack*, cu proprietăţi avansate de protecţie şi reflexie a radiaţiei UV. Noua colecţie a produs deja senzaţie pe piaţa articolelor sport din S.U.A.
Materialele textile de culoare deschisă reflectă totalitatea razelor vizibile şi invizibile, emise de soare, în timp ce materialele de culoare închisă absorb ambele radiaţii. În cazul îmbrăcămintei de culoare închisă, realizată pe baza tehnologiei de finisare Coldblack, absorbţia radiaţiei termice este redusă în mod semnificativ. Rezultatul aplicării noii tehnologii este un management termic mult îmbunătăţit, o protecţie sigură împotriva radiaţiilor UV şi o paletă de culori mult mai largă în realizarea creaţiilor vestimentare destinate atleţilor, care participă la competiţii în aer liber (fig. 1).

Fig. 1

Beneficiile tehnologiei Coldblack, elaborată în conformitate cu standardele Bluesign, au fost recunoscute de ***Under Armour,*** care a implementat-o în gama de îmbrăcăminte sport pentru femei şi bărbaţi, destinată atletismului, golfului şi antrenamentelor sportive.
Companiile Clariant şi Schoeller şi-au mobilizat experţii în Elveţia, Europa, S.U.A. şi în întreaga lume, pentru a desfăşura o intensă activitate de cercetare de laborator, de concepţie şi testare, privitoare la tehnologia Coldblack, în strânsă coordonare cu parteneri din producţie de pe patru continente.
Până acum, au fost elaborate aproximativ 144 de formule Coldblack, pentru diferite sortimente de materiale tricotate şi ţesute, din poliester 100% sau din amestecuri din elastan şi poliamidă, într-o largă gamă de culori.
Articolele de îmbrăcăminte au fost tratate cu Sanitized, un produs antimicrobian, realizat de Sanitized AG şi distribuit în întreaga lume de Clariant, ceea ce le conferă prospeţime, performanţă şi confort în purtare.

Smart*textiles and nanotechnology, iunie 2012, p. 8*

Noi tehnologii

MICROFILTRARE CU AJUTORUL NANOFIBRELOR

Fundaţia de cercetare a Universităţii de Stat din New York a obţinut un brevet de invenţie pentru structuri de susţinere inserate în substraturi neţesute din nanofibre, destinate unei microfiltrări eficiente a bacteriilor, viruşilor, metalelor grele toxice şi ionilor radioactivi.
Anual se înregistrează aproape 1,8 milioane de decese, din cauza apelor contaminate cu unele forme de bacterii, viruşi sau ioni ai metalelor grele toxice, mai ales în ţările în curs de dezvoltare. Un motiv de îngrijorare îl reprezintă şi ionii metalelor grele eliberaţi în mediul înconjurător, în special ca urmare a unor catastrofe la centralele nucleare.
În prezent, procesul de purificare a apei, prin care se elimină cu succes bacteriile, viruşii, ionii metalelor grele toxice şi cei ai metalelor radioactive din sursele de apă, este destul de costisitor, de aceea elaborarea unor tehnologii eficiente de eliminare a acestui tip de contaminare, la costuri reduse, a devenit o necesitate absolută.
Microfiltrarea (MF) este o tehnologie folosită pentru purificarea apei, care separă macromoleculele dizolvate şi/sau particulele în funcţie de dimensiunea acestora, prin trecerea printr-un filtru cu pori fini. Microfiltrul este, în general, o membrană dură, subţire, permeabilă în mod selectiv, care reţine majoritatea macromoleculelor/particulelor ce depăşesc o anumită dimensiune, dar şi majoritatea bacteriilor. Viruşii nu pot fi îndepărtaţi prin microfiltrare, deoarece aceştia sunt prea mici pentru a fi reţinuţi de porii microfiltrului, ci doar prin ultrafiltrare, nanofiltrare sau osmoză inversă – care necesită materiale şi operaţii costisitoare. Apa supusă acestor procese este, în mod normal, pretratată pentru a îndepărta elementele care ar putea dăuna membranei. Adeseori, pretratarea

include trecerea soluției de alimentare printr-un microfiltru. Pentru operațiile de pretratare, ultrafiltrare, nanofiltrare şi osmoză inversă sunt necesare instalații de dimensiuni mai mari, mai costisitoare decât cele utilizate pentru microfiltrare.

Pe lângă tehnicile membranare de microfiltrare cu pori de dimensiuni relativ mari, îndepărtarea metalelor toxice din soluția apoasă se poate realiza şi prin alte metode, cum ar fi schimbul de ioni, neutralizarea, osmoza inversă, precipitarea, extracția solventului şi/sau adsorbția. Totuşi, majoritatea acestor procese au dezavantaje, inclusiv costurile mari de operare rezultate din consumul de produse chimice sau electricitate şi problemele tehnice care pot apărea din cauza perioadei îndelungate necesare extracției, procedurilor complexe de tratare şi producerii nămolului toxic, care este dificil de îndepărtat.

S-a dovedit că, în cadrul acestor procese, adsorbția este o alternativă posibilă din punct de vedere economic, datorită flexibilității proiectării şi operării, precum şi posibilității ei de a produce efluenți tratați, de mare calitate. Datorită faptului că adsorbția, uneori, este reversibilă, substanțele adsorbite pot fi regenerate prin procese adecvate de desorbție.

În Brevetul WO/2012/027242/ martie 2012, al Fundației pentru Cercetare a Universității de Stat din New York, sunt prezentate membrane de microfiltrare, care realizează o retenție puternică a bacteriilor şi viruşilor, precum şi a ionilor toxici şi/sau a celor radioactivi. Membranele au un flux mare de permeație, în comparație cu membranele de microfiltrare convenționale, în condițiile aplicării aceleiaşi presiuni. În plus, ele au mici diferențe de presiune, comparativ cu membranele de microfiltrare comerciale, în condițiile aceluiaşi debit.

Membranele sunt realizate din fibre compozite cu o structură nanofibroasă electrofilată, având diametrul fibrelor cuprins între 50 şi 1000 nm, dispusă pe un substrat microfibros. Membranele multiple pot fi combinate în configurația dorită. De exemplu, două membrane pot fi folosite în serie, fie cu cele două suporturi nanofibroase electrofilate cu fața spre interior şi cele două substraturi cu fața spre exterior sau cu ambele membrane orientate în aceeaşi direcție, fie cu suporturile nanofibroase electrofilate în amonte față de substraturi, fie cu substraturile în amonte față de cele două straturi-suport nanofibroase. De asemenea, straturile cu structură fibroasă compozită pot fi combinate cu nanofibre ultrafine, cum ar fi polizaharidele.

Structura compozită îndepărtează bacteriile în mod eficient, prin excluziunea celor de aceeaşi dimensiune cu porii, stabilită de diametrele fibrelor din stratul-suport. Viruşii şi ionii de metale toxice/radioactive sunt mai mici decât bacteriile şi nu pot fi îndepărtați numai prin excluderea la nivelul porilor. Membranele de microfiltrare din nanofibre ultrafine realizează cu succes retenția viruşilor şi a ionilor de metal.

*Smart**textiles and nanotechnology, aprilie 2012, p. 4*

NOI TEHNOLOGII DE RECICLARE A DEŞEURILOR TEXTILE

Compania ***Laroche S.A.***, din Cours la Ville, Franța, a participat la Expoziția internațională de maşini textile *ITMA Asia*, unde a expus ultimele sale inovații în domeniu:

- Linii de sfâşiere *Jumbo*, cu un flux îmbunătățit şi dispozitive speciale pentru reciclarea deşeurilor provenite de la articole de îmbrăcăminte şi covoare;
- Noua tehnologie cu strat de aer *Flexiloft plus*, care conferă vălului o uniformitate îmbunătățită şi care poate fi aplicată la toate tipurile de fibre şi amestecuri de fibre – sintetice, naturale, reciclate etc., precum şi la amestecurile din fibre şi particule solide, permițând obținerea de produse inteligente din resurse regenerabile şi deşeuri refolosibile;
- Noua linie *Minitrim HSP 400*, de mare viteză, pentru desfibrarea şi tăierea marginilor.

În plus, au fost prezentate cele mai recente inovații în domeniul liniilor tehnologice pentru dozarea de mare precizie şi pentru realizare a amestecurilor, al liniilor de decorticare a fibrelor de bast, precum şi un nou concept de ignifugare a fibrelor celulozice şi reciclate.

Melliand International, mai 2012, p. 100

O NOUĂ GAMĂ DE TEXTILE COSMETICE

Compania ***Eurojersey SpA***, din Caronno Pertusella, Italia, producătoare de tricoturi din urzeală, a realizat o gamă nouă de textile cosmetice, sub marca brevetată *Sensitive Fabrics.*

Conceptul *Sensitive A-more* este descris ca o tehnologie textilă nouă, care oferă celui care poartă articolele textile şi o cremă de întreținere. Această cremă tonifică pielea, făcând-o mai fermă şi revitalizând-o prin aplicarea ingredientelor active într-un mod protector şi corect.

Sensitive Ultra Light Firming, care include ingrediente active, pentru a menține o piele fermă, are capacitatea de a îmbunătăți elasticitatea şi strălucirea pielii. În acelaşi timp, *Sensitive Fabrics Bodyware* asigură o igienă optimă şi un control mai bun al transpirației. *Sensitive Bodyware* țintește să mențină, pe tot parcursul zilei, starea de prospețime a celui care poartă îmbrăcămintea, îmbunătățind confortul acestuia în orice fel de condiții, datorită tratării cu o soluție pe bază de argint. Aceasta împiedică dezvoltarea bacteriilor care produc mirosuri neplăcute, ajutând la menținerea prospețimii articolelor de îmbrăcăminte şi îmbunătățindu-le confortul pentru o perioadă de timp mult mai îndelungată.

Datorită polimerului inovator aplicat pe materialele Sensitive Bodywear, caracteristiclie de protecție ale articolului textil pot fi activate în contact cu temperatura corporală a purtătorului.

Melliand International, mai 2012, p. 69

PROTECȚIE ANTIMICROBIANĂ PE BAZĂ DE ARGINT

Compania ***Sanitized AG***, din Burgdorf/Elveția, producătoare de produse antimicrobiene, a lansat o nouă generație de aditivi, pe bază de particule de argint, care oferă o protecție antimicrobiană mult mai eficientă şi mai rapidă decât produsele utilizate până în prezent şi la concentrații mai mici.
Această tehnologie de încapsulare a argintului în materiale ceramice sau de sticlă în combinație cu produsul cu particule de mici dimensiuni conferă unul din cele mai ridicate niveluri de transparență. Atunci când acest tratament este folosit pentru peliculizări, calitatea şi aspectul estetic ale produsului final nu sunt compromise.
Noua tehnologie poate fi aplicată în mod eficient pentru a conferi protecție împotriva unui mare număr de bacterii, efectul bacteriostatic rămânând stabil până la temperaturi de 500°C. Noile produse sunt compatibile cu o gamă largă de materiale polimerice, respectiv poliolefine, polistiren şi poliuretan, şi, de asemenea, pot fi folosite atât pentru peliculizări aplicate sub formă de pulbere, cât şi în stare lichidă.

Melliand International, mai 2012, p. 72

PROTECȚIE CONTRA RADIAȚIILOR ULTRAVIOLETE

Institutul internațional de testarea textilelor, ***Testex AG***, din Zürich/Elveția oferă informații cu privire la protecția contra radiațiilor ultraviolete, conferită de diverse materiale textile, pentru a preîntâmpina efectele dăunătoare ale acestora asupra pielii. S-a constatat că cea mai bună protecție anti UV este oferită de îmbrăcămintea realizată din fibre artificiale, care încorporează particule de oxid de titaniu, de tipul celor folosite în produsele pentru protecție solară. Aceste particule reflectă o mare parte din energia radiațiilor UV şi, astfel, garantează o protecție excelentă a pielii împotriva razelor ultraviolete. Protecția anti UV oferită de materialele textile este dată de factorul de protecție UPF, care este similar cu cel oferit de cremele pentru protecție solară. Factorul UPF indică de câte ori măreşte produsul respectiv nivelul de protecție naturală a pielii. Astfel, textilele care au factorul UPF cuprins între 10 şi 15 oferă o protecție a pielii împotriva radiațiilor ultraviolete de 10–15 ori mai mare.

Testex recomandă ca, în determinarea factorului de protecție anti UV al articolelor de îmbrăcăminte, să se respecte normativele Standardului UV 801, care are în vedere condițiile de purtare cele mai puțin favorabile. Acest standard este aplicabil pentru toate produsele funcționale plane – textile, îmbrăcăminte, încălțăminte, prelate, umbrele de soare etc., care oferă protecție împotriva radiațiilor UV.

Melliand International, mai 2012, p. 66

Diverse

TOHO ÎŞI VA DUBLA CAPACITATEA DE PRODUCȚIE A CARBONULUI ACOPERIT CU NICHEL

Anticipând cererea crescută pentru ecranarea electromagnetică, compania producătoare de compozite şi fibre de carbon ***Toho Tenax***, din Tokyo – Japonia, care face parte din Grupul Teijin, îşi va dubla capacitatea actuală de producție anuală a fibrei de carbon acoperită cu nichel. Compania intenționează să finalizeze extinderea – la uzina din Mishima/Shizuoka, Japonia – până în ianuarie 2013 şi a estimat o valoare a vânzărilor, pentru anul 2013, de 2 miliarde de yeni japonezi. În plus față de aplicațiile dispozitivelor electronice, Toho Tenax urmăreşte să se extindă şi în sectoarele în care se aşteaptă o creştere a cererii de ecranare electronică, cum ar fi în domeniul aviației şi al vehiculelor electrice.
Toho Tenax consideră că, în combinație cu caracteristicile mecanice excelente ale fibrei de carbon, aplicarea unei pelicule de nichel duce la o conductivitate electrică echivalentă cu cea a metalului. Fibra de carbon acoperită cu nichel poate fi amestecată cu răşini

Fig. 1

şi modelată, pentru a forma compozite care protejează componentele interne de radiația electromagnetică (fig. 1).
Cererea pe piața materialelor de ecranare, care previn funcționarea defectuoasă a componentelor electronice, este în creştere în fiecare an.
În prezent, pentru ecranarea electromagnetică sunt utilizate metode secundare de prelucrare, cum ar fi placarea cu metal a pieselor preformate. Însă, aceste

metode duc la creşterea preţurilor şi au unele consecinţe nefavorabile asupra mediului, ele necesitând evacuarea solvenţilor utilizaţi în procesul de placare cu metal. În consecinţă, compania Toho Tenax consideră că fibra de carbon acoperită cu nichel se va bucura de vânzări crescute.

Sursa: www.teijin.co.jp

STRATURI DE FIBRE UNIDIRECŢIONALE PENTRU PROTECŢIE BALISTICĂ

La Expoziţia pentru apărare şi securitate *Eurosatory*, care s-a desfăşurat în perioada 11–15 iunie 2012, la Paris, a fost lansat un nou produs armat, *Twaron UD21*, cu greutate mare, realizat pe bază de fibre paraaramidice.

Aşa cum precizează dezvoltatorul ***Teijin Aramid,*** din Arnhem – Olanda, *Twaron UD21* este un laminat compozit format din două straturi de fibră aramidică unidirecţională Twaron, aliniate la 90° unul faţă de celălalt. Materialul exploatează pe deplin tenacitatea mare a fibrei Twaron, evitându-se astfel încreţirea fibrei, aşa cum se întâmplă deseori în cazul ţesăturilor. Teijin a dezvoltat o tehnologie inteligentă pentru a alinia fibrele în paralel una faţă de cealaltă, construind separat fiecare strat, cu o matrice de răşină.

Testările efectuate au demonstrat faptul că Twaron UD21 îndeplineşte condiţiile de protecţie, nivelurile 1–4, specificate în Acordul de Standardizare a Organizaţiei Tratatului Atlanticului de Nord (NATO), NATO AEP-55 STANAG 4569, respectiv *Nivelurile de protecţie pentru pasagerii din vehiculele logistice şi blindate uşoare.*

Blindajul dur, optimizat, este necesar pentru a oferi soldaţilor o protecţie balistică superioară, în cazul unor ameninţări de tipul gloanţelor şi fragmentelor de la dispozitivele explozive improvizate (IED) şi al materialelor explozive (EFP). În plus, vehiculele blindate trebuie să aibă capacitatea de a tolera mediile severe ale câmpului de luptă din prezent, unde unele piese ale vehiculelor ar putea atinge chiar şi temperaturi de 90°C, mult peste nivelul de temperatură acceptat în cazul laminatelor tradiţionale de protecţie.

Twaron UD21 poate fi aplicat atât în interior, cât şi în exterior. Pentru o mai bună rezistenţă şi performanţă, Twaron UD21 poate fi folosit în amestec cu alte materiale, precum oţelul, ceramica şi titanul.

Greutatea scăzută, rigiditatea mare şi integritatea structurală a fibrei Twaron are ca avantaje: uşurinţa în manevrare, sarcina utilă mare şi economia de combustibil pentru vehiculele blindate.

Sursa: www.teijinaramid.com

RECENZII

MAŞINI DE FINISARE CHIMICĂ TEXTILĂ
Vol. 2

Autori: ***Iuliu Deac, Magdalena Simona Fogoraşi, Anamaria Albac***

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Lucrarea este structurată în 15 capitole, şi anume: *Sortimente şi fluxuri tehnologice, Maşini pentru piuare, Utilaje de carbonizare, Utilaje pentru crabare, Utilaje pentru vopsit, Utilaje de uscare, Utilaje de aburire-periere, Utilaje de umezit, Utilaje pentru afânat, uniformizat şi curăţat suprafaţa materialelor textile, Utilaje pentru decatarea materialelor textile, Maşini pentru călcat ţesături din lână, Maşini pentru contracţia materialelor textile, Rampe de control, Maşini de măsurat, Maşini de ambalat ţesături.*

Sunt prezentate maşinile şi utilajele folosite în secţiile de finisare chimică textilă din fabricile cu profil textil, precum şi cele mai noi realizări în domeniu, pe plan mondial.

Lucrarea este utilă studenţilor din cadrul institutelor tehnice de profil, cu specializarea inginerie tehnică textilă, precum şi specialiştilor în domeniu, producătorilor şi furnizorilor interesaţi de acest domeniu al industriei textile.

Redacţia

ERATĂ

Redacţia menţionează că, în nr. 3 al revistei Industria Textilă, la paginile 113, 114, 121 şi 130 numele corect al autorului Radu S. Zgarbură este **Radu Sgarbură.**