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THE INFLUENCE OF AIR HUMIDITY ON THE SELECTED REINFORCING MATERIALS OF RUBBER BLENDS

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Abstract: *In this paper, there is the investigation of the effect of air humidity on the physical and mechanical properties of the selected textile and steel reinforcing materials which are used in rubber industry. Furthermore, the adhesion behavior of these reinforcing materials with rubber blends is observed. In relation to the measurements, there is the comparison of the dependence of selected properties of polyester, polyamide cords for the time when they are left in the air and this time is in the range from 0 to 168 h. In the case of the steel reinforcing materials, there is the evaluation of basic physical and mechanical properties and their adhesion with the deposited rubber blends. According to the obtained results, we can conclude that the monitored parameters of the polyamide and polyester cords do not exhibit any significant changes during the investigated time period. Polyamide (PA) and polyester (PES) cords keep the desired values of the tested parameters in relation to increasing humidity content.*
Key words: *PET, PA, physical and mechanical properties, air humidity, adhesion*

1 INTRODUCTION

Reinforcing materials play an important role in rubber technology. These materials are used for production of the rubber products such as tire casings, wedge belts, conveyor belts. The basic division of reinforcing materials includes textile cords, steel cords and tire wire reinforcement [1].
Textile reinforcing materials are original materials that were used for production of the first tire and nowadays, these reinforcing materials are the main material for its construction. The fibers which are used in the function of textile reinforcing materials can be further divided into natural and synthetic fibers. Synthetic fibers such as polyester, polyamide and viscose fibers are used as reinforcing materials in rubber industry. Typical textile reinforcing materials such as PES, PA6, PA66 and aromatic PA are used for manufacturing of the vehicle tire casings. The natural and synthetic fibers or the steel wire embedded in a matrix which consists of polymeric material with low modulus values. The polyamide fibers are the most commonly used fibers which exhibit high strength and good elastic properties. Aramid fibers are also used and these fibers are characterized by high strength, low modulus, low tensibility and high dimensional stability [3].

2 EXPERIMENTAL

2.1 The reinforcing materials and rubber blends

In the paper were used these types of reinforcing materials:

- Textile cord woven fabric – PA66: 940 x 1 (producer: ITA Lousado, Portugal)
- Textile cord woven fabric – PES: 220 x 2 (producer: Kolo, Korea)
- Construction of steel cord: 2 x 0,30 HT (producer: ŽDB, Bohumín)
- Construction of steel cord: 2 + 2 x 0,32 HT (producer: ŽDB, Bohumín)
- Depositional rubber blends that are used for production of tire casings (the exact composition is the know how of the producer).

2.2 The methods and procedures

The determination of humidity content

To determine the humidity content, procedure that is shown in standard was used [4]. Firstly, we used 3 g of sample with a tolerance deflection 0.001 g. Sample was dried for 1 h in hot air drying machine with ventilation at 105°C. After drying, the sample was put into desiccator and left to be cold and then the weight was found out. The two parallel measurements were performed and they were used for calculation of the arithmetic average.

The determination of strength and tensibility of yarns and cords

Method [5] was used for determination of fiber strength and fiber tensibility for cord threads. The determination of strength was connected with the loading process of individual threads until the rupture. Tensibility is maximum elongation of the individual threads at maximum loading and it is expressed as a percentage of the clamping length. Samples of PES and PA were cooled at temperature (24 ± 2)°C and at humidity (55 ± 1)%, for 6 and 24 h, respectively. The other samples of polyamide cord and polyester cord were observed after 24, 48, 120 and 168 h since they had been left in the air. The threads were taken randomly from the whole width of the woven fabric. Minimum length of taken samples was 0.5 m.

The determination of thermal shrinkage

This method [4] was used for the determination of thermal precipitation of textile material in the environment of hot air. The shrinkage is defined as a shrinking of the clamping length due to the temperature, time and prestress. The percentage of shrinkage was determined. Residual shrinkage is defined as residual change in test length after heat shrinkage. Sample was cooled in standard environment while the prestress was kept.

Table 1 The prescribed test conditions

Material	Temperature, °C	Time, min	Prestress, cN/dtex
PA 66, 940 dtex x 1	180	2	0.05
HMLS PES, 2200 dtex x 2	180	2	0.01

The cooling conditions of sample before the test were as follows: 24 h in standard environment, temperature (24 ± 2)°C, the relative humidity (55 ± 1)%. Further samples PA and PES cords were left in the air for 24, 48, 120 and 168 h and then tested.

The determination of strength and tensibility of steel cords until the break

Method [6] was used for the determination of strength and tensibility of supplied steel cords. In order to avoid deterioration of the surface properties, steel cords were stored in PE bag with a humidity absorbent (silica gel). Protection of steel cords samples against unraveling was preserved with fusion of ends using welding machine. The minimum length of tested sample was 1 000 mm.

Static adhesion of steel reinforcing materials

The method [7] was used for the determination of the force that is needed for tearing of steel reinforcing material from the vulcanized mixture block and method relating to the degree of the deposition was also used at the same time. Static adhesion is determined by tearing force of reinforcing material from vulcanized mixture block. The degree of deposition is the amount of remaining mixture on the surface of the reinforcing material after the tearing. The adhesion of steel cords was determined after aging processes and the used aging processes of samples were performed under 3 specified conditions: aging in drying machine, aging in desiccator, and adding in autoclave machine.

The determination of static adhesion (PEEL TEST)

Method [8] was used for the determination of the static adhesion of textile woven fabrics and these textile woven fabrics were joined with rubber. The tearing force and degree of rubber deposition were determined. Static adhesion is determined by force that is needed for tearing of fabric from rubber. Deposition is represented by rubber that remains on the surface of reinforcing material after separation of layers. Cut sample strips were preheated in drying machine for 30 min at temperature (120 ± 2)°C. The tested samples were opened in the length of inserted cellophane foil. The ends of samples were fixed in jaws of the tearing machine so that the stress was uniform through the whole width of tested sample. During the test, the given tested sample is not allowed to be exposed to the torsion force and axes of separated layers have to be in one plane. Separated areas were controlled visually and the degree of fabric deposition by rubber was evaluated.

3 RESULTS AND DISCUSSION

From the aspect of the experimental part, the basic physical and mechanical properties of polyamide, polyester and steel cord were measured. The given materials are commonly used as the reinforcing materials into the tire casing. We recorded the strength, tensibility, loading at elongation to break at 1, 2, 3, 4 and 4.5%. The humidity, shrinkage for the cords and the PEEL TEST was also investigated. After those mentioned tests, we measured adhesion of cords with rubber deposition blends.

3.1 The results for polyamide PA66 940x1 cord

Table 2 shows the physical and mechanical properties of the PA66 940x1 cords which were exposed to air for different time rate.
From the results of mechanical properties of elongation to break at 1, 2, 3, 4 and 4.5% of PA66 940x1 cords (in the air), we can conclude that the content of air humidity did not have any significant affect on the strength, tensibility and loading at elongation to break at 1, 2, 3, 4 and 4.5%. PA66 940x1 polyamide cord kept the properties during the investigated time period. From the measured values for PA66 940x1 cord humidity as well as according to effect of the air, the increase of humidity is observed for the time range from 0 to 48 h. In the time range from 48 to 120, the humidity exhibited the decreasing tendency and after 120 hours of exposure to air, the humidity started to increase. The moisture content was decreased from 48 to 120 h. From the aspect of the shrinkage of PA66 940x1 (in the air), there was not any significant effect of humidity and values of the shrinkage are comparable to the reference value.
Table 3 shows the measured parameters of “PEEL TEST“ for rubber compound and PA66 940x1 polyamide cord in dependence of air exposure. We obtained the cohesion values by the “PEEL TEST“ method. The measured values show that the impact of atmospheric humidity on adhesion of PA66 940x1 to deposition mixture was not significant. The values for rubber surface deposition of PA66 940x1 were decreased due to the time influence but they were suitable in relation to the required tolerance specifications (min. 3%).

Table 2 Physical and mechanical properties of the PA 66 940x1 cords

Time, h	Strength, N	Tensibility, %	Humidity, %	Shrinkage, %
0	76.60	17.53	2.15	3.8
24	78.32	18.25	2.21	3.5
48	77.40	17.89	2.34	3.7
120	78.30	18.67	1.76	3.1
168	70.50	18.60	2.10	3.5

Table 3 The results of the PEEL TEST of PA66 940x1

Time, h	PEEL TEST, N/25mm	Rubber surface deposition, %
0	179.9	4.8
24	186.4	3.5
48	187.4	3.0
120	182.4	3.0
168	181.2	3.0

3.2 The results for PES 220x2 cord

Table 4 shows the physical and mechanical properties of the PES 220x2 cords which were exposed to air for different time rate.

From the aspect of the PES 220x2 cord values for the strength, tensibility and loading at elongation to break at 1, 2, 3, 4 and 4.5% (exposed to the air), we can conclude that the atmospheric humidity did not have any significant influence on the values for monitored parameters. The PES 220x2 cord kept its physical and mechanical properties during the testing procedures. From the measurement of the humidity values for polyester cord 220x2 (exposed to the air), we see a significant increase of humidity during 24 h and it corresponds to the increased susceptibility of PES 220x2 to atmospheric humidity. The shrinkage values of PES 220x2 did not depend on the time representing the exposure to the air because did not recorded a significant impact of humidity and the shrinkage values were comparable to the reference value.

Table 5 shows the measured parameters for “PEEL TEST“ of rubber compound and PES 220x2 cord and it is in dependency on exposure to the air.

On the basis of the obtained values for PEEL TEST, the significant influence of atmospheric humidity on adhesion of PES 220x2 with deposited rubber mixture was not observed. The decrease in rubber deposition was seen after determination of the adhesion based on the results of the PEEEL TEST but all values are in the tolerance range.

3.3 The results for OK 2x0.30HT and OK 2+2x0.32HT cords

The results of measured properties for steel cords were investigated in this section. Table 6 shows the values of adhesion and degree of deposition for the both used steel cords under the different conditions of aging process. The measured values of adhesion were suitable in comparison to the conditions which were defined in the technical specification representing the minimum value 200 N. After aging process, the lowest values were measured in an autoclave machine at 105°C for 120 hours.

Table 7 shows the values for the basic physical and mechanical properties of steel cords such as strength, tensibility and elongation at 100 N for both types of steel cords (OK 2+2x0.32HT and OK 2x0.30HT).

Table 4 Physical and mechanical properties of the PES 220x2 cords

Time, h	Strength, N	Tensibility, %	Humidity, %	Shrinkage, %
0	276	16.98	0.16	1.8
24	279	16.89	0.33	1.8
48	278	17.00	0.32	1.7
120	276	16.91	0.26	1.8
168	273	16.53	0.36	1.8

Table 5 The results for the PEEL TEST of PES 220x2

Time, h	PEEL TEST, N/25mm	Rubber surface deposition, %
0	204.2	4.8
24	186.7	4.5
48	192.8	3.8
120	196.3	4.0
168	202.5	4.0

Table 6 Adhesion and the degree of deposition of steel cords after aging process

Parameter	Aging properties	OK 2x0,30HT	OK 2+2x0,32HT
Adhesion; Degree of deposition	24 h 160 °C/20 min	343 N/10mm 90 %	684 N/12.5mm 98 %
Adhesion; Degree of deposition	dryer 70 °C/48 h	317 N/10mm 90 %	591 N/12.5mm 91 %
Adhesion; Degree of deposition	autoclave 105 °C/120h	263 N/10mm 74 %	464 N/12.5mm 87 %
Adhesion; Degree of deposition	desiccator 70 °C/336 h	277 N/10mm 78 %	552 N/12.5mm 89 %
Adhesion; Degree of deposition	overcuring 160 °C/40 min	291 N/10mm 90 %	503 N/12.5mm 92 %

Table 7 Physical and mechanical properties of OK 2+2x0,32HT and OK 2x0,30HT cords

Sample	Strength, N	Tensibility, %	Tensibility at 100N, %
OK 2x0,30HT	442	2.04	0.37
OK 2+2x0,32HT	935	2.01	0.27

4 CONCLUSION

According to the given investigations and obtained results we could analyse the effect of air humidity on the physical and mechanical properties of selected textile and steel reinforcement materials as well as we were able to come to conclusions in relation to the adhesion of the given reinforcement with rubber deposition mixture. In the case of PA and polyester cords, we can conclude that the strength, tensibility, loading at elongation, shrinkage and adhesion were not changed from the aspect of the time influence. Based on the increasing humidity, the investigated textile cords exhibited the desired values of the tested parameters. We investigated the effect of aging process on the value of the adhesion between the steel cords and used deposited rubber mixture. All measured values of adhesion showed the suitable values. According to the mentioned facts, our investigation led to the confirmation that the given parameters of tested steel and textile reinforcing materials in time range for 168 hours (7 days) were suitable from the aspect of the physical and mechanical properties. Mentioned conclusions confirm the possibility to use these reinforcing materials during the production of the tire casings because there was not any influence on the physical and mechanical properties as well as adhesion. We kept all the required conditions in relation to the packaging, storage and manipulation with these reinforcing materials.

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VPLYV VZDUŠNEJ VLHKOSTI NA VYBRANÉ VÝSTUŽNÉ MATERIÁLY KAUČUKOVÝCH ZMESÍ

Translation of the article

The influence of air humidity on the selected reinforcing materials of rubber blends

Sledujeme vplyv vzdušnej vlhkosti na fyzikálne a mechanické vlastnosti vybraných textilných a oceľových výstužných materiálov používaných v gumárenskom priemysle a tiež ich adhéziu ku kaučukovej zmesi. V rámci meraní porovnávame závislosť vybraných vlastností polyesterových a polyamidových kordov od doby státia na vzduchu v časovom rozpätí 0-168 hodín. V prípade oceľových výstužných materiálov sa hodnotili základné fyzikálno-mechanické vlastnosti a ich súdržnosť s nánosovou kaučukovou zmesou. Na základe výsledkov môžeme konštatovať, že v prípade polyamidových a polyesterových kordov sa hodnoty sledovaných parametrov výrazne nemenia v rámci sledovaného časového obdobia. Polyamidové i polyesterové kordy si i s narastajúcim obsahom vlhkosti zachovávajú požadované hodnoty testovaných parametrov.

MODULOR SYSTEM IN PRACTICE

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Abstract: *This article deals with the harmony of proportions and shapes of the human body and how they have been interpreted through the centuries, and the Modulor system by Corbusier in particular. This system is used and laboratory verified during the somatometric measurement of Czech men. The differences of bodily height dimensions are related to the Modulor system. Measuring was supplemented by measurements of dynamic dimensions in Modulor positions and girth dimensions measured in dynamic postures, such as in sitting position, forward bending and upper limb bending at the elbow. The results of all bodily dimensions, but particularly the dynamic ones, can be applied in the projection of clothes. Other applications include the determination of working activities within ergonomics and sports anthropology.*
***Key words**: proportionality, anthropometry, Corbusier, Modulor system, dynamic postures of the human body, bodily dimensions*

1 INTRODUCTION

Human body dimensions have been subject to the interest of artists since ancient times. Ancient sculptors did not just create their works on the basis of artistic intuition but also on the basis of calculated proportions. Based on aesthetic analysis and experiments, it was discovered that some numeric relations are often repeated. One of these mysterious relations is the golden ratio. Philosophers dealing with aesthetics found the golden ratio of the human body in a ratio of lengths above and below the waist. These body parts can be divided again into two parts at a ratio of 0.618:1. The golden ratio is, however, a statistical value. It is an ideal average and does not apply 100% to everybody. Moreover, it applies for a “unisex” person because it is the mean of values measured in women and men. In fact, the value is slightly lower than 0.618 for men and higher for women. The degree of bodily beauty depends on how close its proportions are to the average, or normal, proportions [1].

2 THE SET OF PROPORTIONS AND RELATIONS OF INDIVIDUAL BODY PARTS

The term ***canon*** (Greek kanwn = stick, ruler, set of rules) is used for human body proportions – size relations between their individual parts. We know ancient Egyptian canon, Polycleitean canon, Praxitelean canon and Vitruvian canon, while in the Renaissance era we must mention Leonardo da Vinci and Albrecht Dürer. Several works of this kind were developed in the 18th and 19th centuries: J. Marshall, G. Fritsch, A. P. Losenko, P. Richer, J. Kollmann, G. Bammes and others. These studies were carried out by doctors (so the studies are of anthropological character) or artists (these elaborate on the topic of so-called plastic anatomy) [2].

Canon is a set of human proportions which is idealized for the purpose of achieving formal aesthetic perfection. In contrast, ***anthropometry*** identifies and states actual dimensions expressed in centimetres and millimetres or in feet and inches, and identifies the variability of the human figure for further work [2].

If artists construct or use canon (model dimensions), they must realize that even a good canon is not applicable in all cases, especially the extreme ones. In practice, proportions are felt rather than measured. Many canons were created through history, some of which many art schools still use [1].

Saltire is the canon of the Roman builder Vitruvius. The length of the upper limbs spread out equals the body height and so the human body can be plotted into a square. He circumscribed a circle around the figure; its centre is the navel, which became a natural centre but not a halving point of the body. During the Renaissance Leonardo da Vinci and Albrecht Dürer used these so called Vitruvian figures [1].

Adolf Zeissing declared the rule of golden ratio to be the law of proportionality. According to the rule, the distance from the top of the head to the navel to the distance of the navel from the floor is at the same ratio as this distance is to body height. The golden ratio applies, according to the rule, to all parts of the body (for limbs too), therefore the length of the forearm with hand to the length of arm is in the same ratio as the length of whole upper limb to forearm with hand. His canon is used rarely because the canon figure has a table, the application of which is rather complicated [1].

The most significant work in this field in the 20th century is ***Le Corbusier's Modulor***. Here the proportional relations are given by the Fibonacci number and the proportion of the golden ratio. Only very recently have there been rare attempts to scientifically determine average dimensions based on repeated measuring, and thus to establish not the ideal of beauty but the normal figure [2].

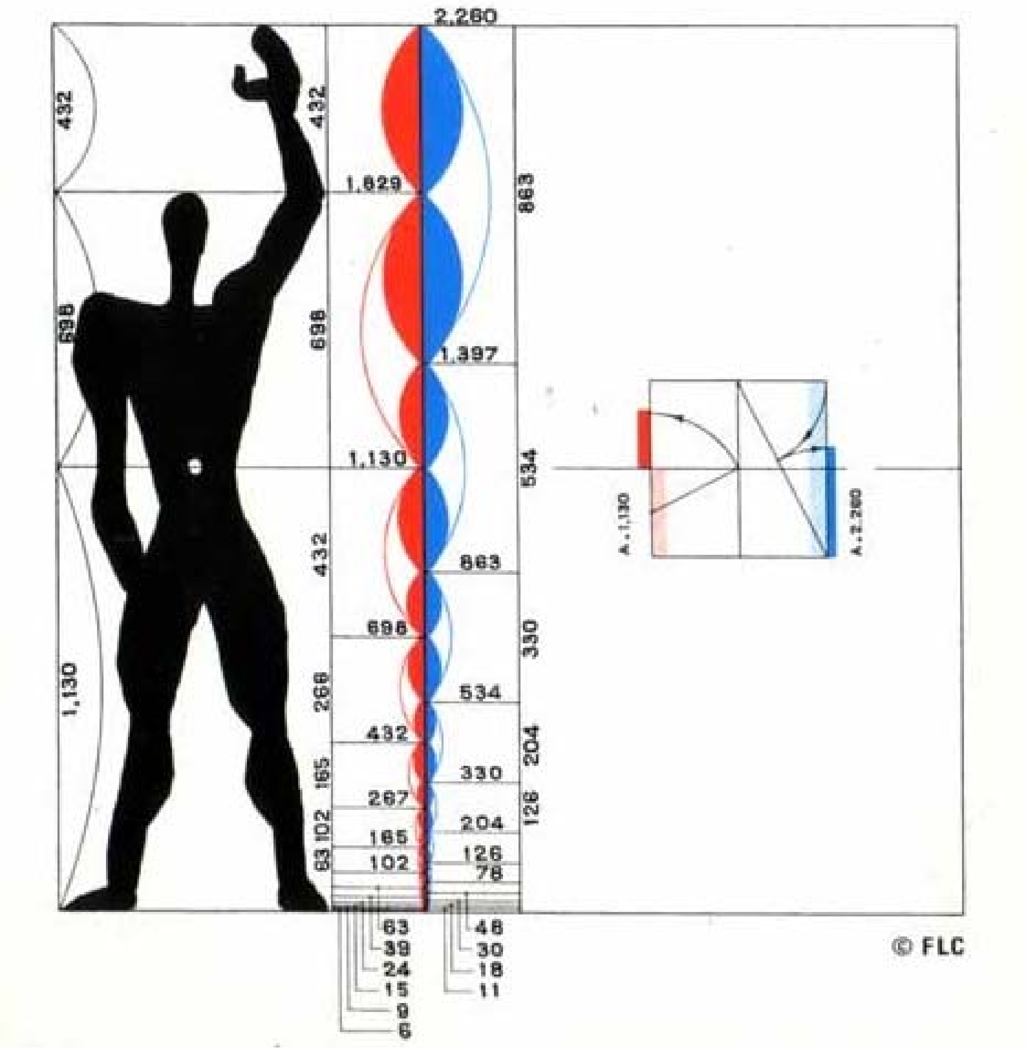

Figure 1 Le Corbusier's “Modulor” proportional system [4]

3 THE MODULOR PROPORTIONAL SYSTEM

The French architect Le Corbusier claimed that nature was a substance of mathematics. To ensure an appropriate environment for themselves, humans projected the system of nature into geometry. Using geometry he searched for the perfect proportion; it was represented by the golden ratio for him. Using the golden ratio he tried to think up a universal proportional unit that would be based on the human figure and that, upon application, would achieve the aim of best serving people thanks to its usefulness... this was the MODULOR [3].

The Modulor is a system of proportions based on ratios of a standing person's proportions and the proportions of a person with an arm stretched upwards, whose height is divided into the golden ratio and which starts at the navel Figure 1. Each section of the first set of dimensions is half of the second set. Both of them drawn into one picture provide division, where halving occurs as well as division by the golden ratio. The Modulor became the basis of the harmonious rule of modern architectural geometry [1].

4 EXPERIMENT

4.1 Application of Modulor in anthropometry

The Modulor is not only a tool of architectonic ratio but also a means to ensure that designed objects correspond to bodily dimensions resulting from anthropological measurements. Different positions of the human body during various activities Figure 2 that can be applied in anthropology, for example while projecting clothing products intended especially for work and sports, and for ergonomic purposes, are entered into the Modulor system. Cooperation between anthropologists and production ensures the monitoring and study of the somatic state, variability and growth of populations presented by a change of bodily dimensions, human body shape and certain variability of dimensions as a consequence of dynamic moves, which they use to continue their work. The selection of bodily dimensions in dynamic postures can be based on the positions of the human body defined by the Modulor.

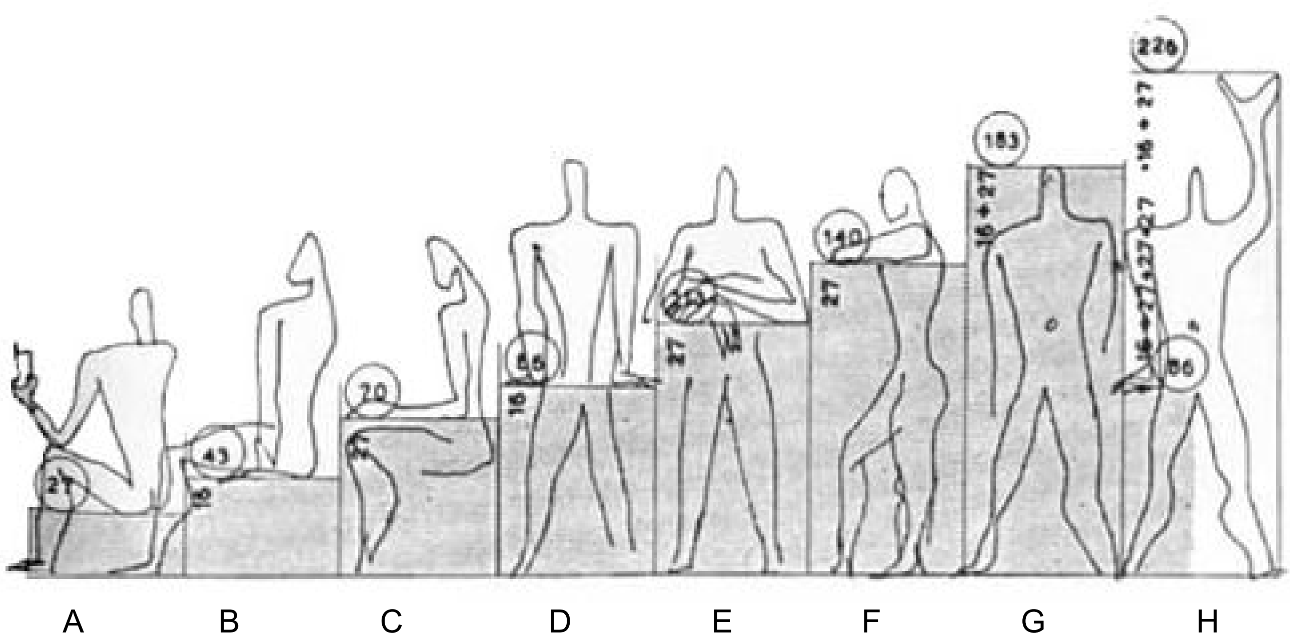

Figure 2 Position of human body in accordance with the Modulor system [5]

Individual positions measured in accordance with Corbusier are defined in Table 1. Based on the positions mentioned, somatometric measurement of bodily dimensions in static and dynamic posture was carried out; their names, the method of measurement and an illustration of measurements can also be seen in Table 1. A set of 30 men aged from 30 to 50 were selected for somatometric measurements carried out in 2012 [6].

The following ***height dimensions*** were measured: A – lowered sitting position, B – standard sitting position, C – standard sitting position with bent arm, D – upright position with leaning palms, E – upright position with leaning elbows and legs slightly apart, F – upright position with leaning elbows at horizontal level, G – upright position with legs slightly apart, arms are free along the torso, H – upright position with legs slightly apart, one arm lifted above the head and the other one leaning by palm against support; ***dynamic dimensions***: Anterior length of lower limb – A1, B1, D2, F2; Lateral lengths of arm - C1, D1, E1, F1, H1 [6].

Table 1 Dimensions measured on the body in positions as per the Modulor system [6]

Definition of positions and dimensions measured on the body in the positions as per the Modulor system						
Position	Measuring height dimensions			Measuring dynamic dimensions		
	Definition of the position	The method of height dimensions measurement	Picture of the measurement	The method of dynamic dimensions measurement	Measuring lateral arm length	Measuring anterior length of lower limb
A Sitting figure	Decreased sitting position, limbs naturally bent, feet touching the floor	Measured from the base level to the level of sitting A		Measured from anterior sitting groove through the centre of kneecap to interior side of ankle A1		
B Sitting figure	Standard sitting position, limbs naturally bent, feet touching the floor	Measured from the base level to the level of sitting B		Measured from anterior sitting groove through the centre of kneecap to interior side of ankle B1		
C Sitting figure	Standard sitting position with arm bent into the right angle, feet touching the floor	Measured from the base level to elbow C		Measured from shoulder through elbow to wrist C1		
D Standing figure	Upright position of the body slightly leaning forward, legs slightly apart, arms in vertical position palms leaning against support and directing outwards the body	Measured from the base level to palm D		Measured from shoulder through elbow to wrist D1. Measured from anterior sitting groove through the centre of kneecap to interior side of ankle D2		

E Standing figure	Upright position of the body slightly leaning forward, legs slightly apart, arms in vertical position with elbows bent, wrist touching breast nipple	Measured from the base level to elbow E		Measured from shoulder through elbow to wrist E1		
F Standing figure	Upright position of the body with right leg put forward slightly, elbow bent in the level of breast nipple while touching the nipple by thumb	Measured from the base level to elbow F		Measured from shoulder through elbow to wrist F1. Measured on right leg from anterior sitting groove through the centre of kneecap to interior side of ankle F2		
G Standing figure	Upright position with legs slightly apart, arms along the body	Measured from the base level to top of the head G				
H Standing figure	Upright position with legs slightly apart, right arm lifted bent into the right angle, thumb above the shoulder, the other arm is along the body	Measured from the base level to palm and from thumb of the lifted arm to the base level H		Measured from shoulder through elbow to wrist H1		

4.2 Mathematical and statistical processing of somatometric research

The evaluation of measurement was conducted by calculating the statistical characteristics and normal (or Gaussian) probability distribution. The set of measured bodily dimensions was further processed and assessed using Excel.

The assessment of bodily height dimensions measured in positions as per the Modulor system in men in the Czech Republic in 2012 together with the values of the Modulor system are shown in Figure 3.

The differences that appeared between the measurements in 2012 and the Modulor are caused by the quantity of the set of men measured in 2012 and how Le Corbusier created the sequence. The sequence of his numbers corresponds to mathematical calculation and in progression they correspond to the dimensions of the so-called ideal European.

Normal division can be used to describe the measured height dimensions. If individual measurements of bodily height dimensions are illustrated graphically, the mean value as well as standard deviation can be read from the chart of normal division. In Figure 4, there is an interval estimate of the mean value in the form of (μ±σ) [7].

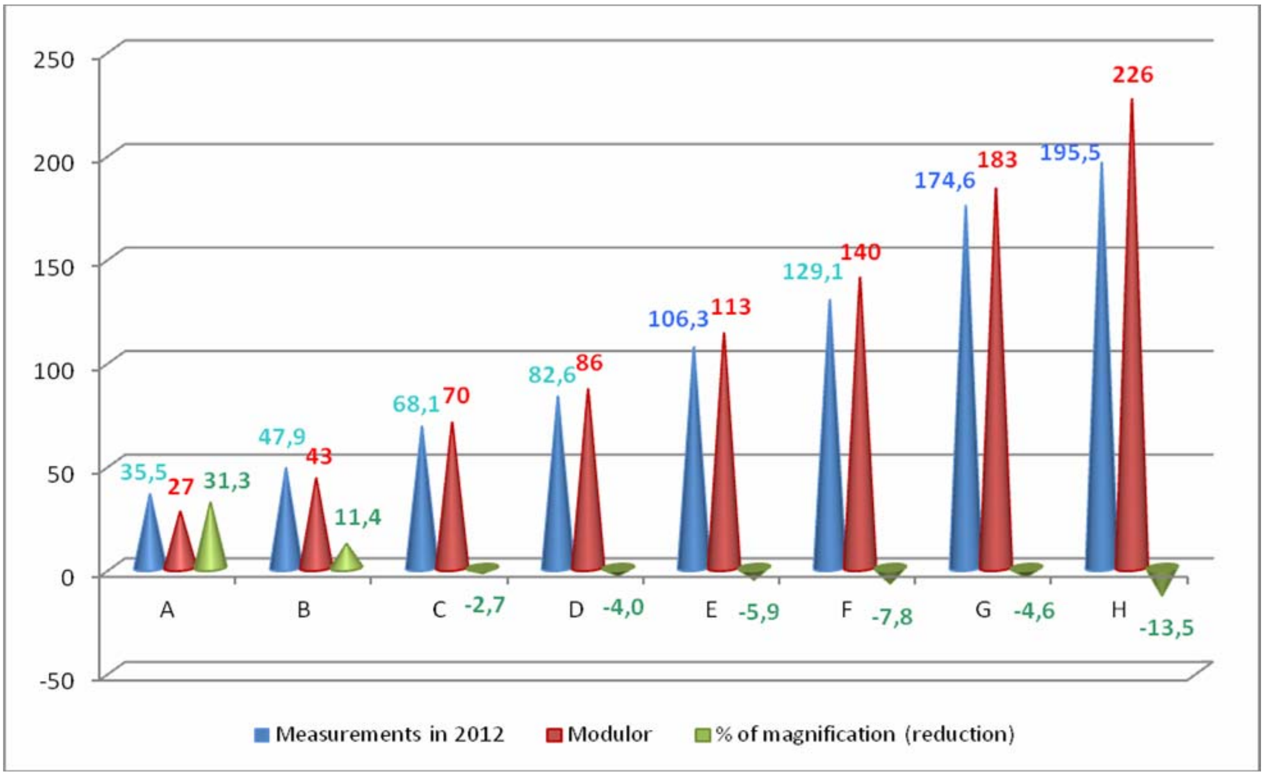

Figure 3 Average values of bodily height dimensions of Czech men and the values of the Modulor system

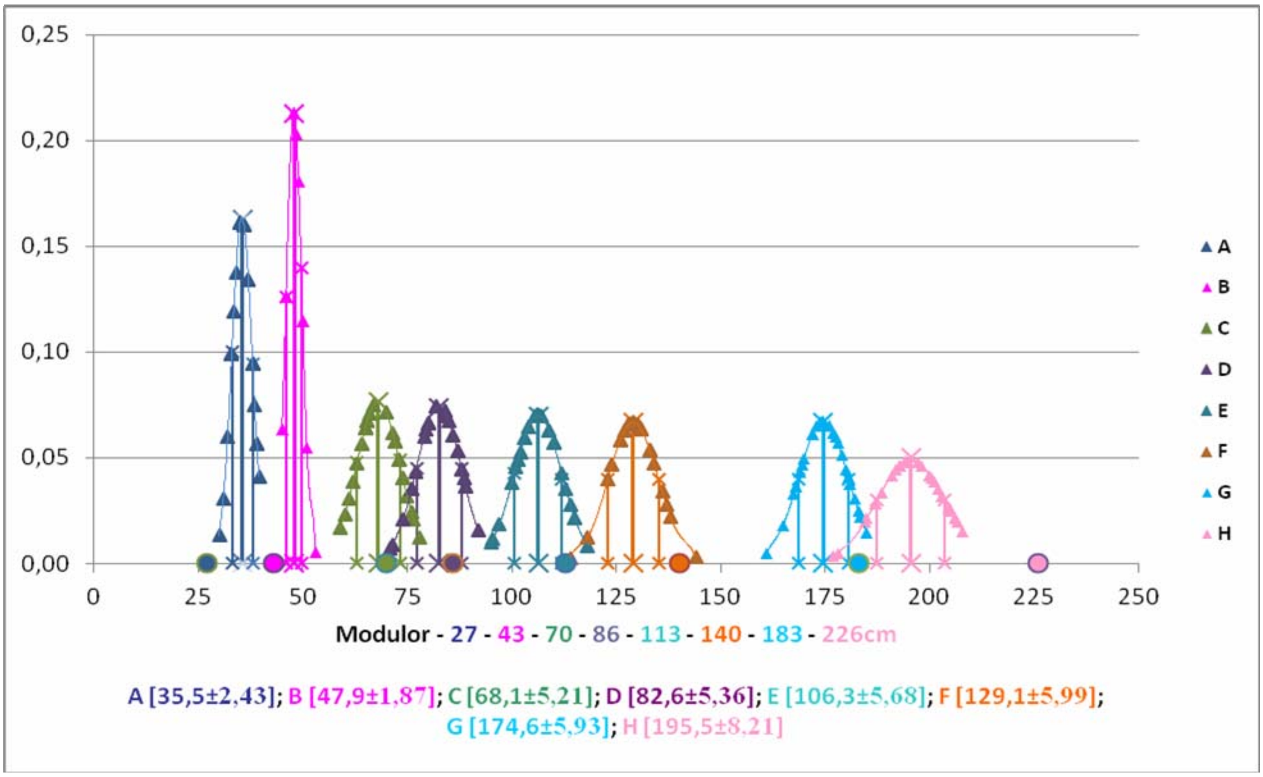

Figure 4 Assessment of normal division of bodily height dimensions of Czech men and the values of the Modulor system – colour dot

It is evident from Figure 3 that the measured values of A, B dimensions are higher than the values of the Modulor; in C, D dimensions, the Modulor dimension ranges within the interval of μ+σ of measured values of dimensions and the measured values of E, F, G and H dimensions are lower than the Modulor dimensions.
Figure 5 gives an assessment of bodily dimensions in dynamic ***D*** and static postures (static dimensions) ***S*** in men in the Czech Republic in 2012, i.e. lateral lengths of arm and anterior lengths of lower limbs in measured positions as per the Modulor system. The ***K*** bodily dimension measured in static posture is measured from the anterior sitting position groove to the base level – average value K=81.1cm and ***R*** is measured from the shoulder to wrist – average value R=59.1cm.
Due to the dynamic posture, the increase of bodily dimensions is monitored in both lower and upper limbs. The H1 dimension, the value of which is lower compared to the R dimension in static posture by 3.2%, is an exception.
Depiction of the results of measurements of bodily dimensions in dynamic postures A1 to H1 and the average values of K and R measured in static posture is graphically illustrated in Figure 6 using normal division.

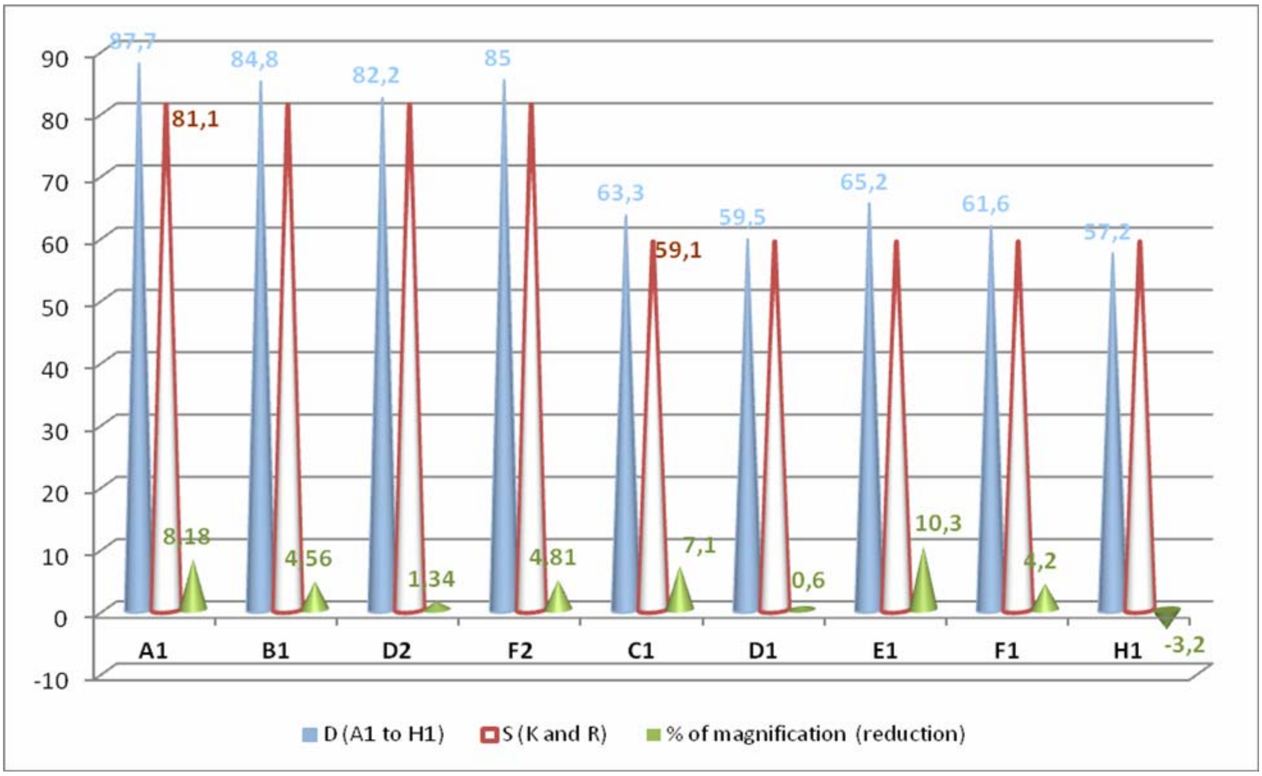

Figure 5 Dynamic and static bodily height dimensions of Czech men measured in body positions in accordance with the Modulor system and their differences

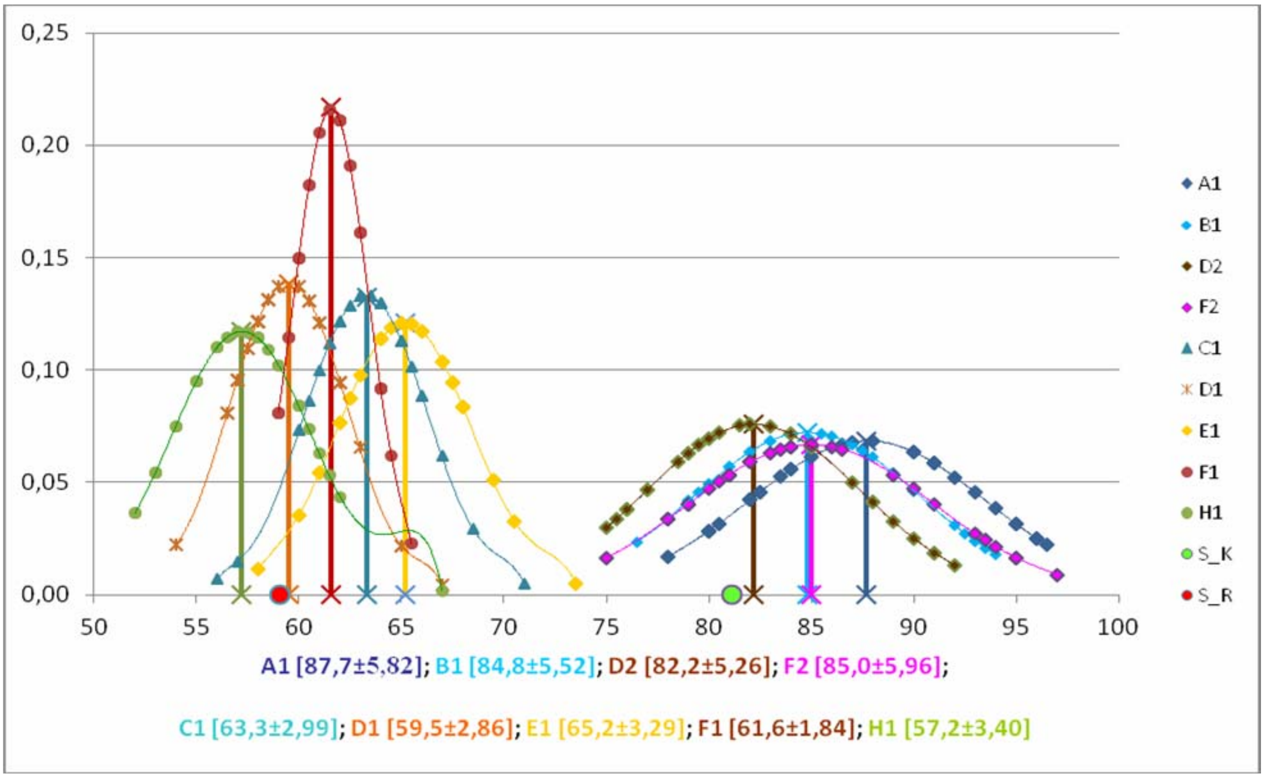

Figure 6 Dynamic and static bodily height dimensions of Czech men and average values of ***K*** and ***R*** dimensions measured in static position – colour dot

The chart depicts the scope of dimensions measured in dynamic posture in upper and lower limbs of the human body. In upper limbs we can expect the addition for dynamics within the interval from *D2-5.26 cm* to *A1+5.82 cm*. In lower limbs we can expect an interval for dynamic addition from *D1-2.86 cm* to *E1+3.29 cm*. The type and scope of human activity will matter.

Girth dimensions in static posture *chest girt – Chg, waist girth – Wg, hip girth – Hg, arm girth – Ag, elbow girth – Eg, wrist girth – Wrg, back length – Bl, back width – Bw* and ***dynamic posture*** were measured too – ***in standard sitting position with bent leg***: *chest girth – Chg_sp*, *waist girth – Wg_sp, hip girth – Hg_sp;* ***at upper limb bent at elbow:*** *arm girth – Ag_be*, *elbow girth – Eg_be, wrist girth – Wrg_be*; ***in forward bent position:*** *back length – Bl_fbp*, *back width – Bw_fbp.*

The assessment of bodily girth dimensions measured in static and dynamic postures in men in the Czech Republic is in Figure 7.

Due to the change of bodily position, i.e. in sitting position, in forward bent position and in upper limb elbow bent, an increase is monitored in dynamic girth, length and width dimensions. No change occurred in wrist girth.

Depiction of the results of measurements of girth and length dimensions in static and dynamic postures can be seen in the chart of normal division in Figures 8 and 9.

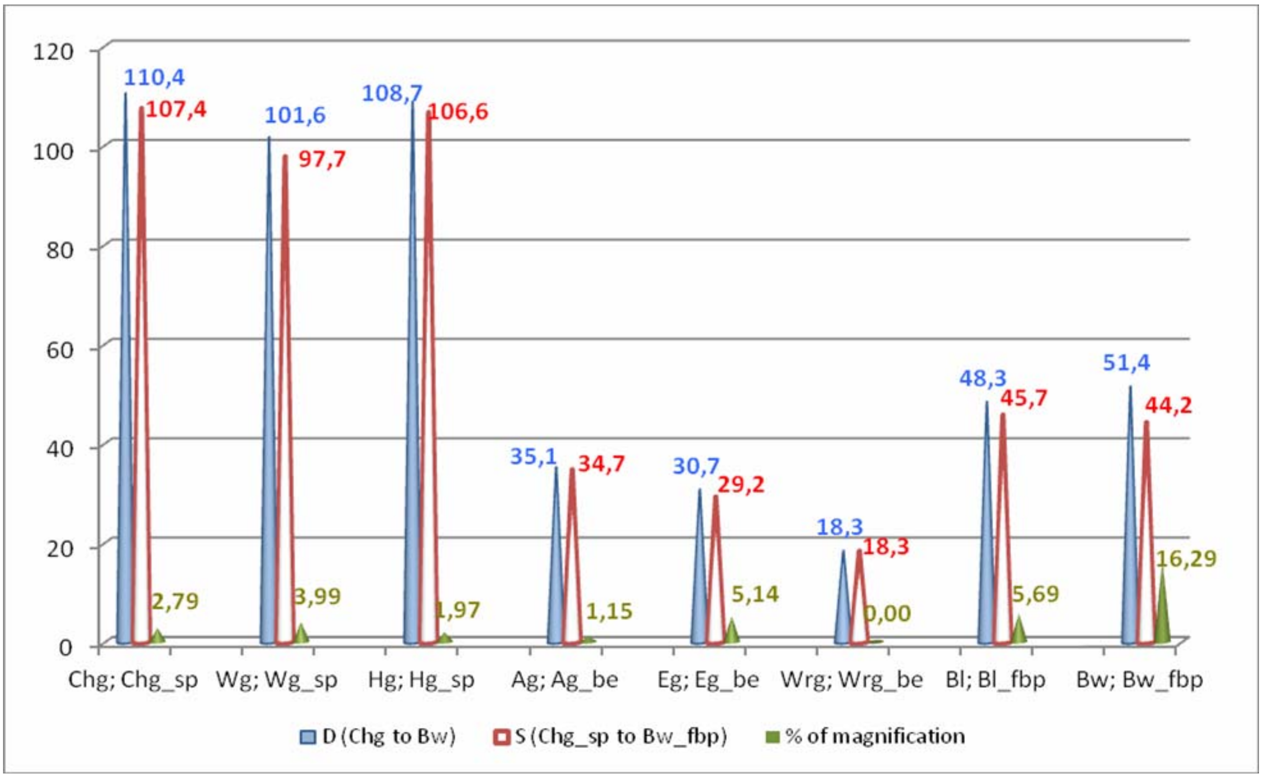

Figure 7 Differences of ***girth, length and width dimensions*** in static and dynamic postures in Czech men

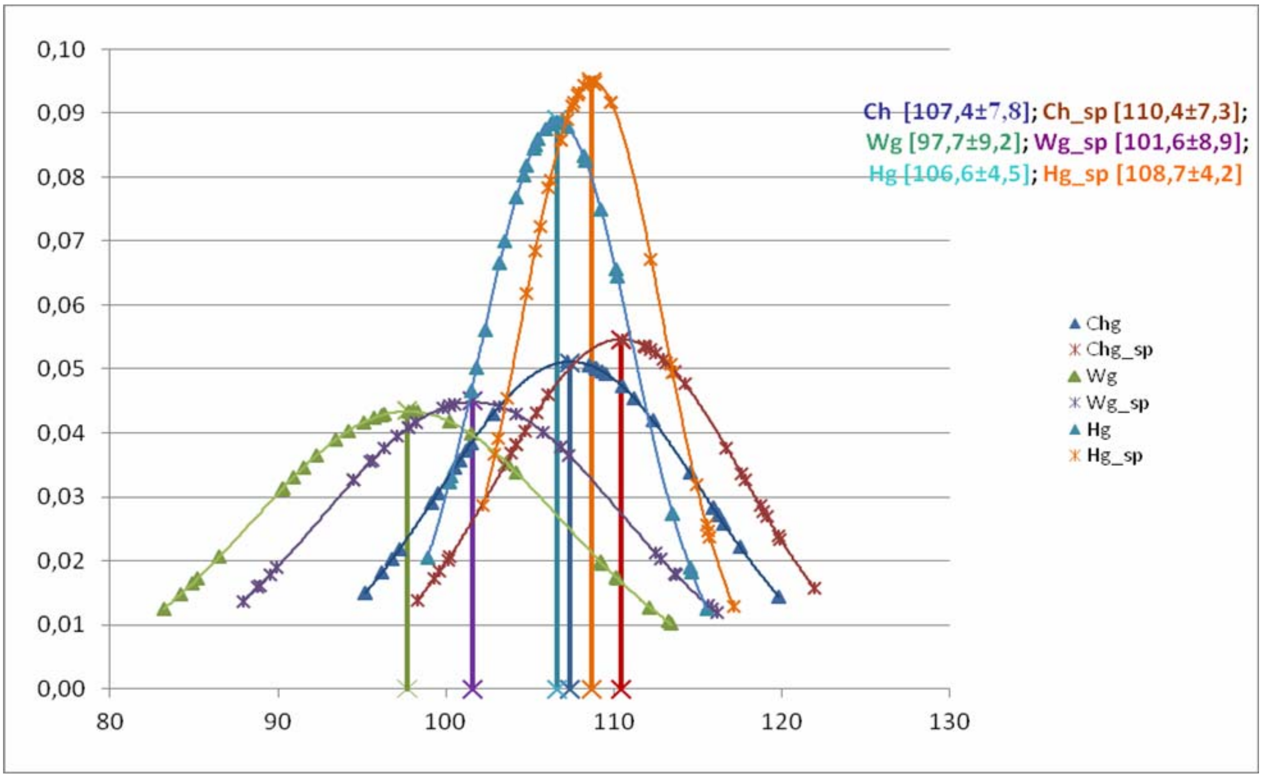

Figure 8 Assessment of normal division of bodily basic girth dimensions of Czech men measured in static and dynamic positions

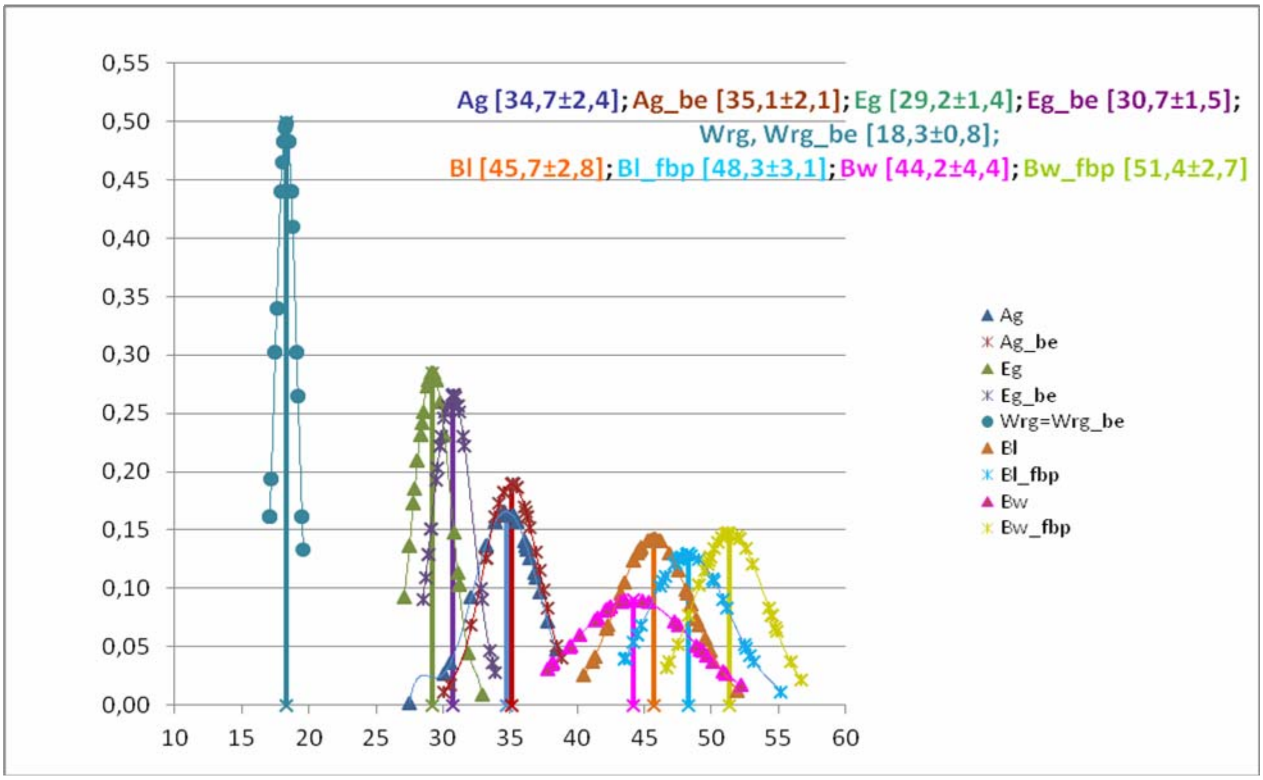

Figure 9 Assessment of normal division of bodily girth, length and width dimensions of Czech men measured in static and dynamic postures

All the dimensions measured in dynamic posture should be accepted in applied anthropology, thus in light industry and ergonomics at design and production of goods intended for direct use by people. In practice, the extent of average value of bodily dimension in static posture plus – minus one standard deviation (μ±σ) is sufficient.

4.3 Application of the results of somatometric measurement

The application of anthropometric data in various fields is extensive and theory and applications have been elaborated upon substantially. The above mentioned research and its results are of considerable importance during the projection of clothing products.

The critical and special adjustment of the ready results of the research before their delivery to production, during which the producer cooperates closely, is very important. Properties of the material, economical aspects and users' comfort and satisfaction are taken into consideration here. It is not efficient to try to satisfy all customers at any cost. It is not necessary to carry out measurements every time.

All the ascertained bodily dimensions in dynamic postures and the percentage of their changes compared to the dimensions measured in static postures need to be reflected in the creation of the clothes cut. These dynamics have an especially significant impact during the production of selected kinds of working clothes and clothes intended for selected kinds of sports, namely when creating construction documentation. The percentage increase of given dimensions can be reflected in the clothes cut as the dynamic addition ***Pd*** so that their amount is proportionally divided into individual construction line segments formed from bodily dimensions.

Table 2 The values of dynamic additions to bodily static dimensions

Anterior length of lower limb	**A1**	**B1**	**D2**	**F2**				
Pd [%]	8.18	4.56	1.34	4.81				
Pd	**1.02**	**1.05**	**1.01**	**1.05**				
Lateral length of arm	**C1**	**D1**	**E1**	**F1**	**H1**			
Pd [%]	0.07	0.60	10.30	4.20	-3.20			
Pd	**1.07**	**1.01**	**1.10**	**1.04**	**-1.03**			
Girth and length dimensions	**Chg**	**Wg**	**Hg**	**Ag**	**Eg**	**Wrg**	**Bl**	**Bw**
Pd [%]	2.79	3.99	1.97	1.15	5.14	0.00	5.69	16.3
Pd	**1.03**	**1.04**	**1.02**	**1.01**	**1.05**	**1.00**	**1.06**	**1.16**

Construction line segment is generally defined as per the following formula:

$$\overline{AB} = k * T_i + P + a \quad (1)$$

$$P = Pv + Pp + Pd \quad (2)$$

where: $\overline{AB}$ - relevant construction segment line, k – proportional part of bodily dimension, T_i – bodily dimension, P – sum of additions (Pv – for looseness, Pp - for thickness of material layers, Pd – for dynamics), a – absolute term.

Dynamic addition (***Pd***) is given by the difference of relevant bodily dimension measured in dynamic and static postures and is calculated from the measured average. The dynamic addition is given for individual construction segment lines by the multiplication of bodily dimension or its part and Pd addition as per the following table.

5 CONCLUSION

Corbusier's Modulor, which became the basis of architecture in general, was probably developed with the intention of adapting all things and everything that surrounds us to people and our requirements. It enriched the possibilities of somatometry with new views and ways of measuring the human body for artists and for practical use.

The research mentioned showed the differences of the Modulor system in relation to somatometric research of Czech men and the possibilities and way of integration particularly of the dynamic effect into the projection of clothing products intended mainly for demanding works and sports.

The research is of benefit for application in ergonomics too. It provides important information about the possibilities of the human organism when moving and when selecting a type of person, work activity and modification of workplace, or during sport performance.

The research confirmed that with regard to population differences, the results need to be followed and consulted with anthropologists, producers in various fields and, last but not least, with users.

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SYSTÉM MODULOR V PRAXI

Translation of the article
Modulor system in practice

Článek je zaměřen na řešení harmonie proporcí a tvarů lidského těla a jejich řešení v průběhu staletí, zvláště na Corbusierův systém Modulor. Tento systém je použit a laboratorně ověřen v rámci somatometrického měření českých mužů. Rozdíly výškových tělesných rozměrů jsou vztažené k systému Modulor. Měření bylo obohaceno o měřením dynamických rozměrů v pozicích Modulor a rozměry obvodovými měřenými i v dynamickém postoji, tj. vsedě, v předklonu a v ohybu horní končetiny v lokti. Výsledky všech tělesných rozměrů, ale zvláště dynamických, lze uplatnit při projekci oděvů. Další využití je možné při stanovování pracovních činností v rámci ergonomie, případně sportovní antropologie.

RELATION BETWEEN NEEDLE AND NEEDLE-LESS ELECTROSPINNING USING POLY (ETHYLENE OXIDE)

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Abstract: *We predict a relation between needle and needle-less electrospinning, as the needle-less or roller electro spinning is a time consuming and expensive procedure, so poly (ethylene oxide) with different molecular weight, concentration and additives was tested on needle and needle-less electrospinning with changing solution and process parameters (molecular weight, voltage supply, distance between electrodes, addition of NaCl-salt) whereas the ambient parameters (temperature and humidity) were kept constant.*
Results show a great relationship between needle and needle-less electrospinning particularly in terms of spinnability, fiber quality, non-fibrous area, fiber diameter, fiber diameter distribution and throughput. Our result can be useful in predicting the behavior of polymers in needle-less electrospinning with results from needle electrospinning.
Keywords: *electrospinning, relationship electrospinning, needle-less electrospinning*

1 INTRODUCTION

The use of electric charge to break up liquids into small particles has been well known and extensively studied for over a century. This is true for both electro spraying, in which low viscosity liquids can be atomized into droplets, and electro spinning, in which viscoelastic liquids can be transformed into filaments of nanometer dimensions. With the emergence of nanotechnology, researchers become more interested in studying the unique properties of nanoscale materials. Electrospinning, an electrostatic fiber fabrication technique, has evinced more interest and attention in recent years due to its versatility and potential for applications in diverse fields. The notable applications include in tissue engineering, biosensors, filtration, wound dressings, drug delivery and enzyme immobilization [1]. Needle electro spinning technique includes many aspects as mechanism of electrospinning, materials for electro spinning, properties of nanofibers, factors effect to spinning process and to products properties, etc, as summarize by Anthony L. Andrady [2] or Jon Stanger and his co-workers [3]. Up to now, Nanospider is the unique commercial equipment to produce nanofibres web via needle-less electrospinning technology. This equipment, which is first patented by Jirsak [4], enable to produce membranes collected fibers in a range from 100 to 600 nm of diameter [6].

1.1 Aim of the work

Needle-less electro spinning is a quite new technique. As it is expensive and time consuming process so the objective of this work is to find some type of relationship between needle and needle-less electrospinning so that it can be easily predicted by the results of needle electrospinning which is comparatively cheap and time saving process.
The central point of experimental work will be to test poly (ethylene oxide) (PEO) with different molecular weight, polymer concentration and additives, etc. with changing solution and process parameters (Molecular weight, voltage supply, distance between electrodes, addition of NaCl-salt) whereas the ambient parameters (temperature and humidity) were kept constant. The result will be examined on SEM to find relationship between needle and needle-less electrospinning particularly in terms of spinnability, throughput, fiber quality,

fiber diameter, non-fibrous area and fiber diameter distribution.

2 METHOD

- Firstly PEO with Molecular weight 100,000 g/mol; 400,000 g/mol and 900,000 g/mol from ALDRICH Company were taken and solutions of different concentrations are made in water solvent.
- Needle electrospinning is done with changing parameters like voltage, distance from collector plate, syringe pump speed and concentration of solution, whereas temperature and relative humidity are kept constant.
- The polymer samples were then tested on needle-less electrospinning with changing parameters of voltage, distance from collector, speed of roller and speed of fabric on which nanofibers are laid whereas temperature and relative humidity are kept constant.
- Different amount of NaCl–salt (ALDRICH quality p.a.) is added and polymer solutions are then tested on needle and needle less electrospinning.
- Deionized distilled water is taken to make solution.
- Results are evaluated with the pictures from electron microscope, which is then observed on image analysis software to detect the fiber diameter and non-fibrous area.
- Observations and calculations are done to make a comparison between needle and needle-less electrospinning regarding, conductivity, viscosity, surface tension, fiber quality, throughput, non-fibrous area and effect of NaCl-salt, fiber diameter and fiber diameter distribution.

Before electrospinning, some properties of solutions have been measured such as viscosity, surface tension and conductivity .Surface tensions of solutions were measured by Kruss apparatus using plate method. The conductivities of solutions were measured by conductivity meter OK-102/1 branded Radelkis and viscosity were measured on ROTOVISCO RV1.

3 RESULTS

Followings results are obtained with repeated experiments. Figures 1 and 2 show that throughput of needle electrospinning increases with increasing polymer molecular weight and/or its concentration in solution.
Figure 3 shows the decrease of throughput with the addition of NaCl-salt, as addition of salt causes the huge amount of ions into solution which causes conductivity of solution increase strongly. Figure 4 shows how the conductivity of solution increases by the addition of NaCl-salt.

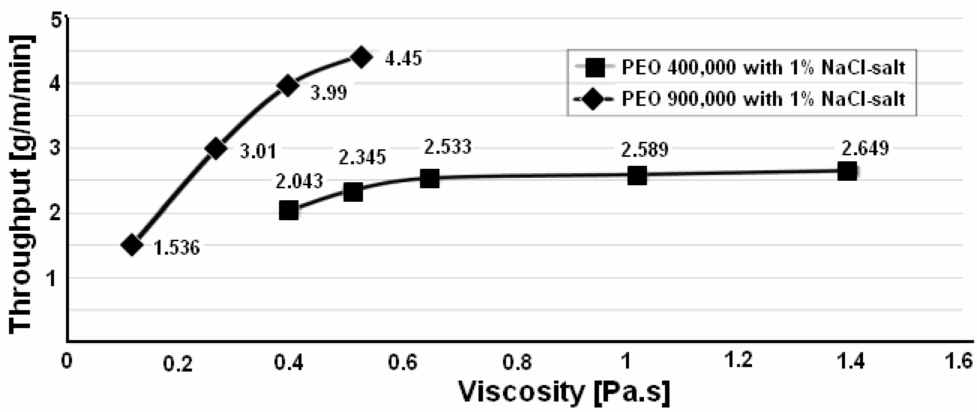

Figure 1 Comparison of viscosity and throughput

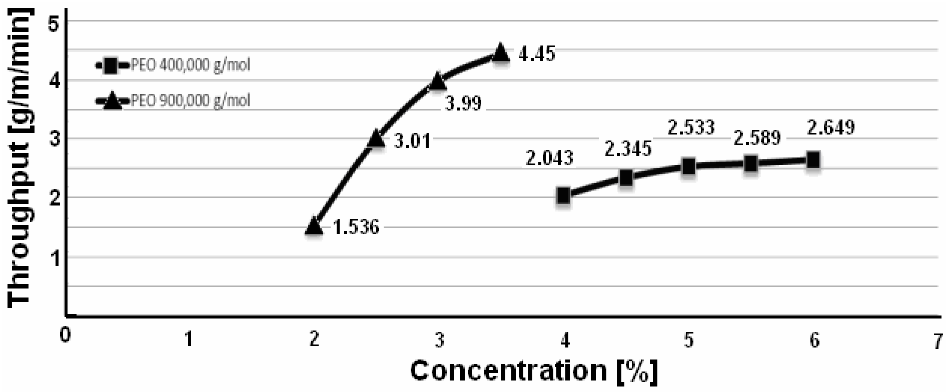

Figure 2 Comparison of concentration and throughput

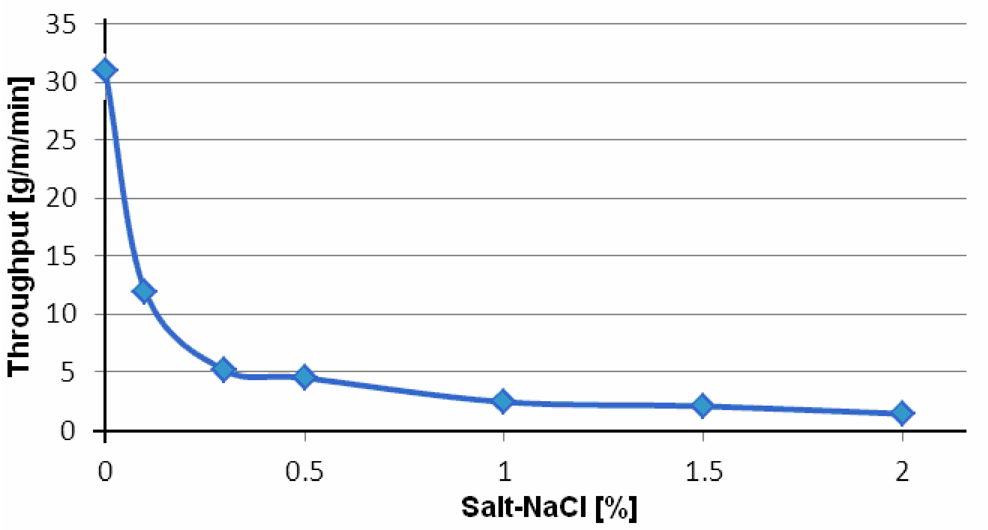

Figure 3 Throughput of PEO Mw 400,000 with 6%concentration of NaCl-salt

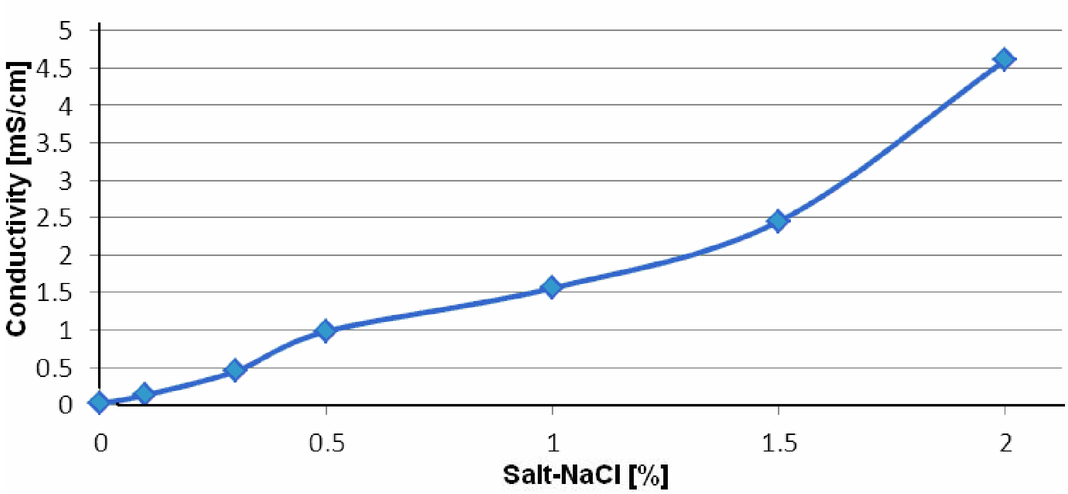

Figure 4 Effect of NaCl-salt on conductivity

Figure 5 shows the insignificant effect of NaCl-salt on the surface tension property of solution.

Figure 6 shows the effect of salt percentage on the non-fibrous areas of needle-less electrospinning, which decreases by a 10 times with the addition of 0.5%

Whereas for needle electrospinning the non-fibrous areas only exist when spun without the NaCl-salt as shown in the Figure 7.

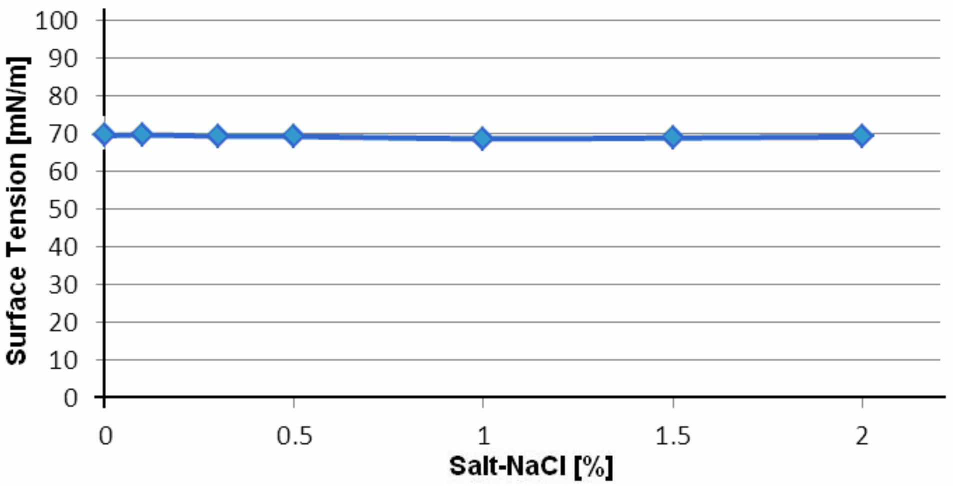

Figure 5 Effect of NaCl-salt on surface tension

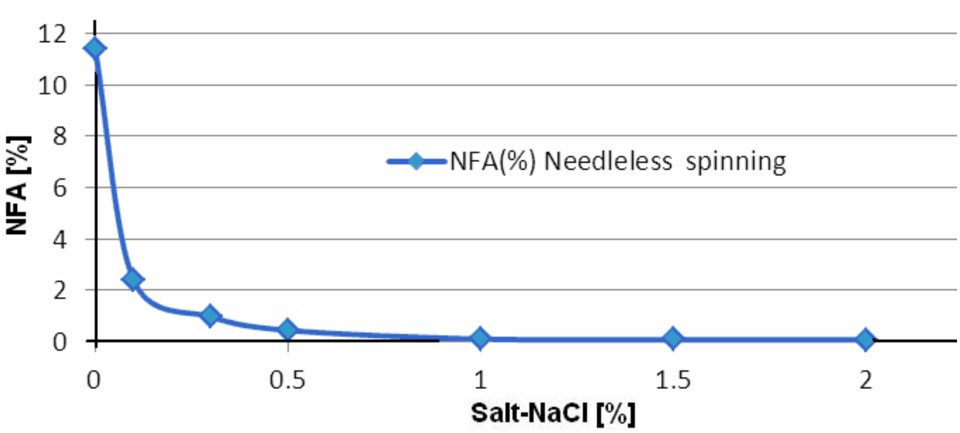

Figure 6 NaCl-salt and NFA in needle-less electrospinning

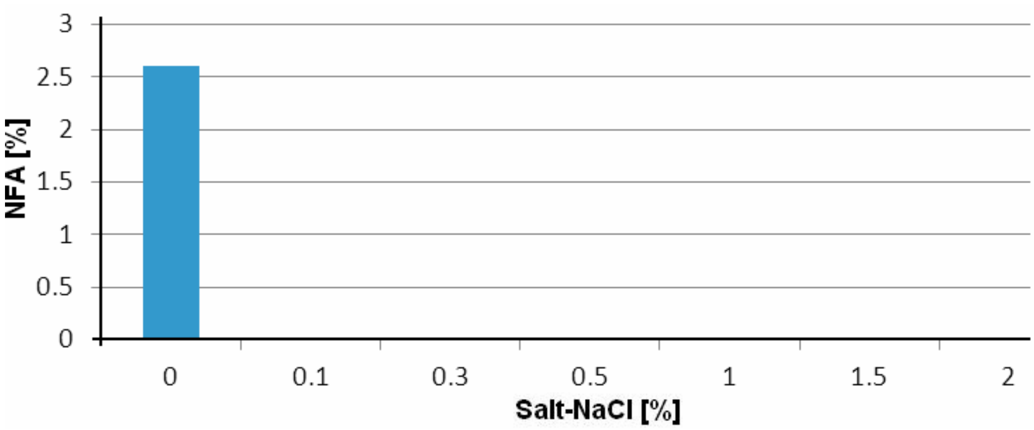

Figure 7 Effect of NaCl-salt effect on NFA in needle electrospinning

Figure 8 shows the throughput of roller electrospinning, in which fibers were not produced for any concentration of PEO 100,000 g/mol whereas increase of concentration of other solutions caused increase in throughput and addition of salt caused the throughput to decrease.

Figure 9 shows the comparison of fiber diameter produced by needle and needle-less electrospinning of PEO solution.

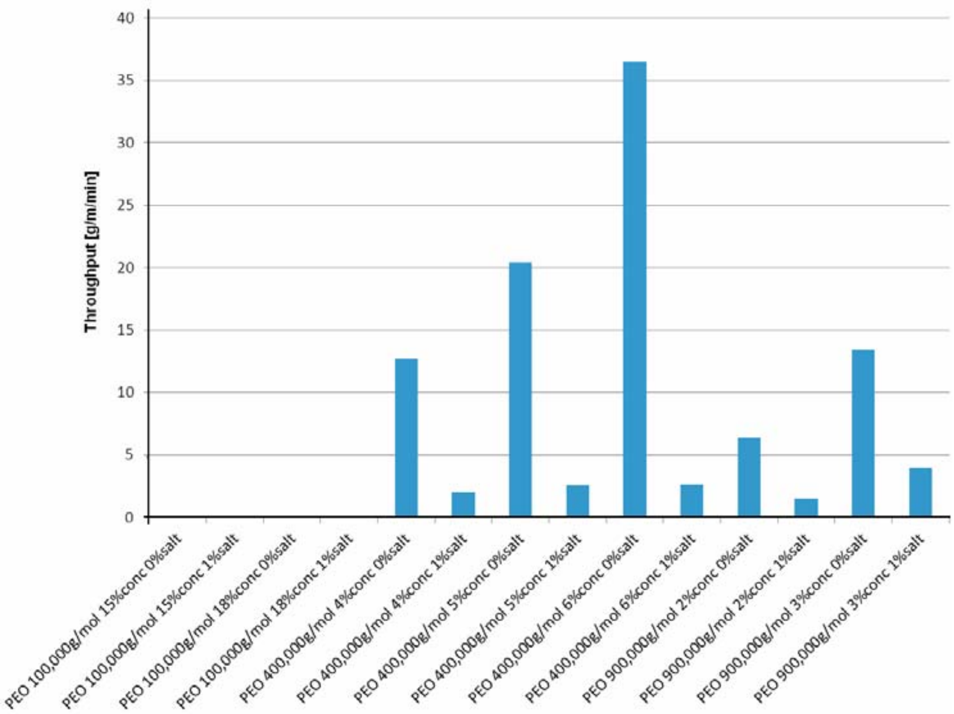

Figure 8 Roller electro-spinning throughput graph

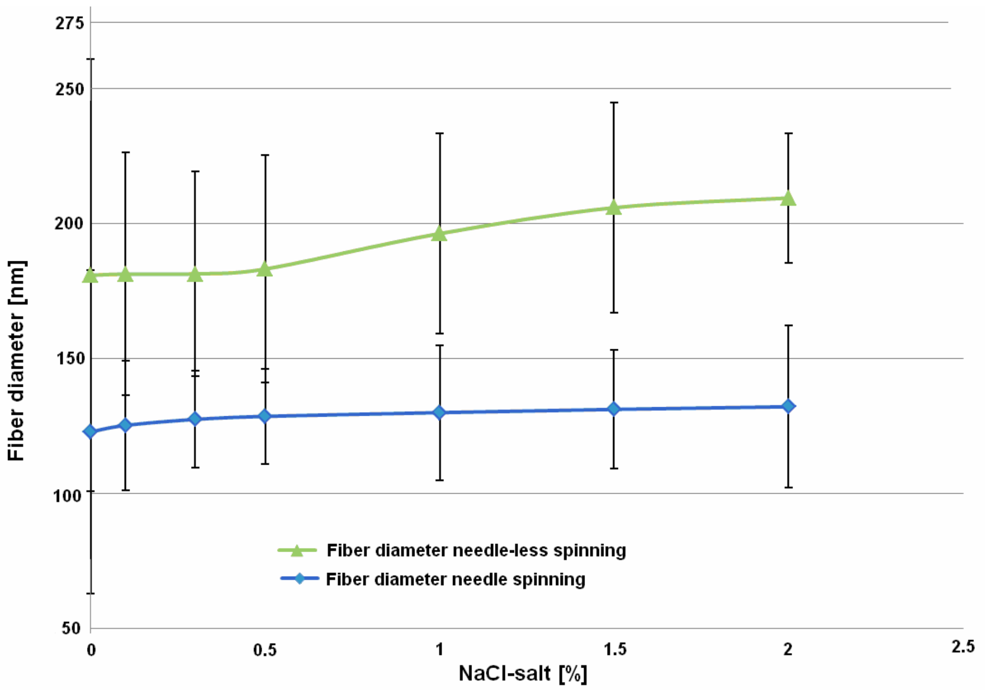

Figure 9 Comparison of fiber diameter of needle and needle-less electrospinning

3.1 Fiber diameter distribution

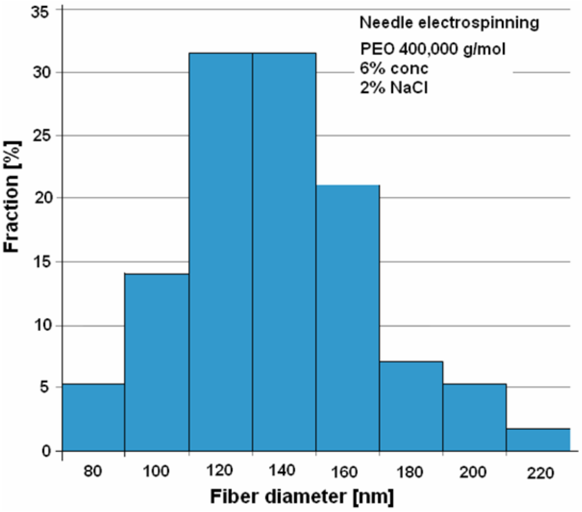

Figure 10 Fiber diameter distribution of PEO 400,000 g/mol, needle spinning

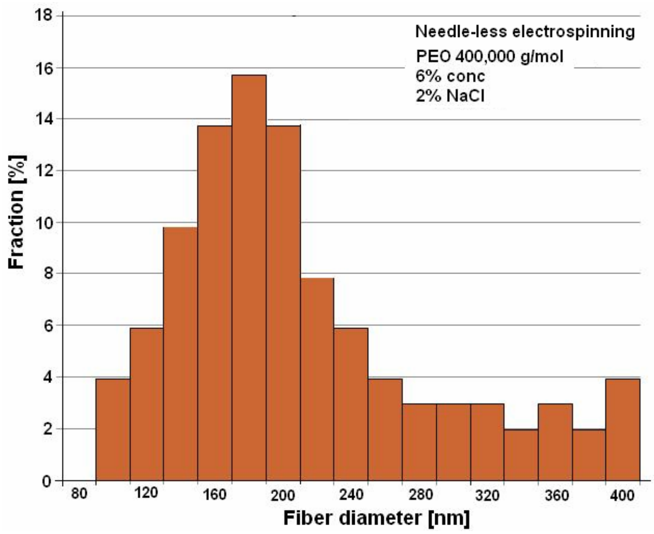

Figure11 Fiber diameter distribution of PEO 400,000 g/mol, needle-less spinning

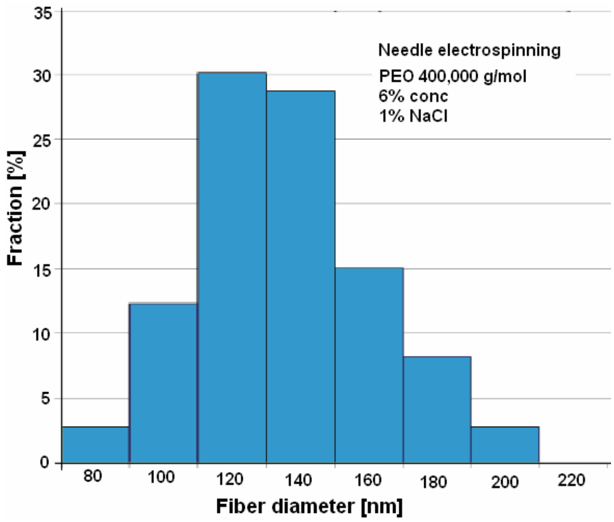

Figure 12 Fiber diameter distribution of PEO 400,000 g/mol, needle spinning

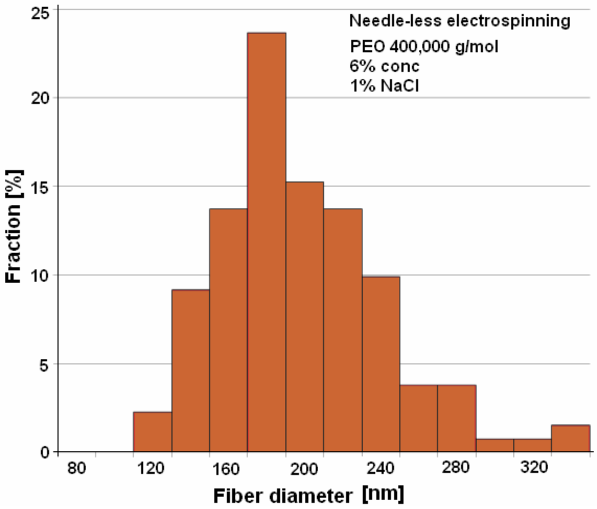

Figure 13 Fiber diameter distribution of PEO 400,000 g/mol, needle-less spinning

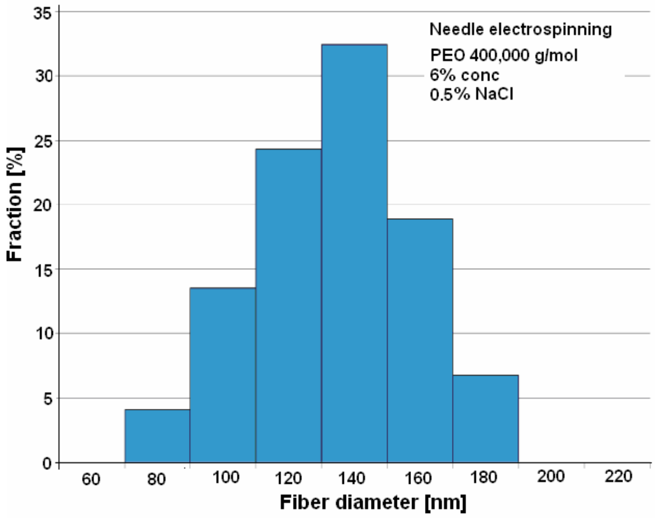

Figure 14 Fiber diameter distribution of PEO 400,000 g/mol, needle spinning

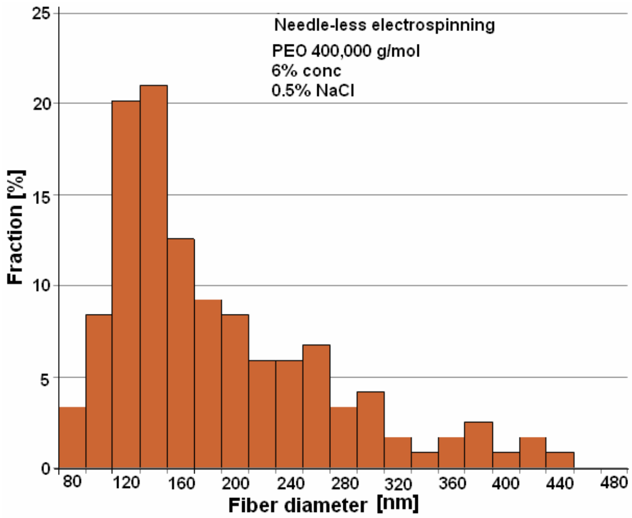

Figure 15 Fiber diameter distribution of PEO 400,000 g/mol, needle-less electrospinning

4 DISCUSSIONS

4.1 Effects of polymer molecular weight and its solution concentration

The results illustrated in above results shows that the differences in electric conductivity and surface tension of studied solutions are not significant. Conditions of electrospinning were the same for all the materials. Therefore, we can assume that only molecular weight of polymers and concentrations of solutions are responsible for significant differences in spinnability, throughput and fiber quality.

There is a significant difference between a needle and surface (or roller) electrospinning process. In the hollow needle, the polymer solution is moved ahead by mechanical forces. Thus, it is transported to high field strength position where it has the best conditions for spinning process. When the spinning occurs, spinning jet is always supplied with fresh solution by mechanical forces. When leaving the needle, the solution is formed by electric field into droplets or fibers, depending on polymer properties. In the roller electrospinning, Taylor cones are created on the surface of polymer solution as described by Lukas at [5]. In the spinning process, the jet always must seek for food (supply of fresh material) from surrounding of Taylor cone. Otherwise the Taylor cone disappears in short time because of lack of fresh polymer solution. Certain level of the strength is necessary to enable the jet to suck in fresh solution. Strength of the jet depends on the level of intermolecular entanglements. The jet is simultaneously a tool for electrical forces to take polymer material from free surface of polymer solution. If the intermolecular entanglements and the jets are strong enough, the spinning process will continue. On the contrary, if the jets are weak, they break in a very short time, Taylor cones disappear and the spinning process stops.

Thus, non-stable formation of solution typical for low molecular weight polymers and for electro-spraying in the needle process does not start spinning process on the roller.

The second condition for a stable Taylor cone is the ability of the solution to feed Taylor cones with fresh material from surroundings. This requires limited solution viscosity and suitable rheological behaviour. A stable Taylor cone is able to yield a jet during several seconds to tens of seconds.

4.2 Effect of conductivity

By adding various concentration of sodium chloride, the surface tension and viscosity of PEO polymer solution do not change significantly. On the contrary, conductivity of the solution increases strongly with increasing concentration of sodium chloride. It means that sodium chloride does not affect the structure of PEO solutions. This slightly increases the friction coefficient between molecules inside solution. On the other hand, it brings a huge amount of ions into solution which causes conductivity of solution increase strongly.

4.3 Fiber diameter

Figure 10 clearly shows that the fiber diameter of needle spinning is much less than that of needle-less spinning and the fiber diameter distribution shows that in needle-less spinning the fiber diameter is distributed with greater standard deviation (Figures 10-15).

Because in needle-less spinning there are more chances of material to be pulled apart from the roller and stick to the fabric or ground plate as compared to needle-less spinning.

5 CONCLUSIONS

Needle-less electrospinning is a technique using electrical forces to tear and push spinning materials from free surface liquid toward electrode collector. Whereas in the hollow needle, the polymer solution is moved ahead by mechanical forces. .Up to now, Nanospider is the unique commercial equipment to produce nanofibres web via needle-less electrospinning technology. This work includes parameter of needle and needle-less electrospinning and then comparing with each other to find a relation.

From literature, it is obvious that polymer molecular weight and concentration of solution have significant effects on some dependent parameters of needle electrospinning such as fiber diameter and throughput. Once again, they play an important role in needle-less electrospinning and strongly affect some dependent parameters of needle-less electrospinning such as throughput and fiber diameter. The results of experiments show that throughput and fiber diameter increase with increasing polymer molecular weight and/or its concentration in solution.

- The higher is the viscosity of polymer solution (no matter whether caused by higher molecular weight or polymer concentration) the higher is the throughput (Figure 2) and higher fiber diameter. Influence of molecular weight and concentration is similar – throughput depends on viscosity and shows increase with increase in viscosity (Figure 1) but in some range of molecular weight (Figure 2).
- Conductivity of spinning solution affects strongly electrospinning dependent parameters, especially the throughput (Figures 3 and 4).explained in the discussion part. As huge amount of ions are added in to solution with addition of NaCl-salt that causes a decrease in throughput for needle-less spinning (Figure 4).
- PEO 100,000 g/mol is non spinnable even if viscosity and conductivity is high enough. The PEO solution which did not spin on needle electrospinning or giving electrospray, did not spin in roller electro spraying too (Figure 8).
- The fiber quality of needle electrospinning is better than needle-less electrospinning and fiber diameter is less as compare to needle-less electrospinning (Figure 9).
- Adding NaCl-salt decreases the non-fibrous area in both needle and needle-less electrospinning (Figures 6 and 7).
- Fiber diameter distribution of needle-less electrospinning has more standard deviation as compared to needle electrospinning as explained in discussion part (Figures 10-15).

6 FUTURE WORK

As needle-less spinning is a new and time consuming process so to find more relatable parameters between both type of electrospinning different polymer solutions with different additives should be experimented to get a clear and strong relationship so that from the results of needle electrospinning it can be predicted about the behaviour of polymer solution at needle-less electrospinning. This research work is an initiative regarding the relationship between needle and needle-less electrospinning. Amount of current required to produce a nanofiber could be possibility to find relation between both the electrospinning processes.

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VZTAH MEZI JEHELNÍM A BEZ JEHLOVÝM ELEKTROSTATICKÝM ZVLÁKŇOVÁNÍM S VYUŽITÍM POLY (ETYLÉN OXIDU)

Translation of the article

Relation between needle and needle-less electrospinning using poly (ethylene oxide)

Bezjehlové elektro-zvlákňovaní pomocí zvlákňovacích válečků je časově náročný a drahý proces, proto jsme hledali vztah mezi jehelním a bezjehlovým elektrostatickým zvlákňováním. Testovaní bylo prováděno s využitím poly (etylén oxidu) s různými molekulovými hmotnostmi, koncentraci a aditívy a s nastavením rozdílných procesních parametru (napětí, vzdálenosti mezi elektrodami, přídavkem NaCl-soli) v průběhu zvlákňovacího procesu. Okolní podmínky v průběhu testovaní (teplota a vlhkost) byly udržování konstantní. Výsledky ukazují velikou závislost mezi jehelním a bezjehlovým elektrostatickým zvlákňováním zejména pokud jde o zvláknitelnost, jakost vlákna, oblasti zvláknitelnosti, průměr vláken, průměrnou distribuci vláken a výtěžnosti procesu. Naše výsledky jsou užitečné při hodnocení chování polymerů při jehlovém a bezjehlovém zvlákňovaní.

CHARACTERISTICS OF «FAST FASHION» CONCEPT IN FASHION INDUSTRY

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Abstract: *The research contains the analysis of main principles, making the «fast-fashion» concept successful, reveals the key criteria, according to which the brands are classified as «fast-fashion». The present publication reflects the core principles of fashion business entities activity within the «fast-fashion» segment and specifies the criteria of singling out the target consumer audience. The concept under consideration is viewed as a factor of fashion business vector transformation. The research claims that within the high-responsiveness concept the fashion product is being developed and manufactured based on mass-market customer demand, its attitude towards fashion changes and life-style, rather than designer approaches.*
Key words: *fashion industry, fast fashion, subjects of fashion industry, fashion product, total look, designer's brand, flagship store*

1 INTRODUCTION

It is generally admitted that fashion industry, as any complex production system, is oriented at planning the production and advertising strategy, as well as forecasting the emerging consumers' demand, rather than meeting it. Non-stop acceleration of life tempo and manifold increase in social and economic competition in society triggers the stepping-up of consumer-related processes and expansion of consumers' demand boundaries. Currently the main consumer's trend lies in replication of new needs and reduction of consumption cycles.

Such a situation, no doubt, resulted in appearance of great many fashion industry entities [1], engaged in design, promotion and sales activities, thus triggering integration of «fast-fashion» high-responsiveness concept into industry itself. The most comprehensive definition of fashion business high-responsiveness was articulated by Leslie Davis Burns and Nancy O'Bryant in "The Business of Fashion" - "definitions of this phenomenon are subject to change depending on industrial sector in mind. The textile industry views the high-responsiveness in coordinated work of thread, fabric and clothes producers. For cloth designers high-responsiveness means frequent resorting to technologies and establishing connection with fabric and clothes producers, as well as retail stores" [2, 3].

2 ANALYSIS OF PREVIOUS RESEARCHES AND PUBLICATIONS

Experience has shown that high-responsiveness concept may be characterized as a factor of fashion business vector transformation. Previously the fashion industry was based on "from producer to final user" scheme, preconditioning the routine character of designing and production, as well as automatically determining the relevance of the produced fashion piece and its demand. In literature practicing designers term this principle "pushing" (the products are pushed to the sales and use stages) [4]. In opposition to this the functioning of high-responsiveness concept is viewed as "engaging" principle, as the fashion product manufacturing process is activated only by emerging demand or necessity to refresh the fashion product pursuant to the mass-market customer demand (consumer's "getting" of the fashion product from the manufacturing system).

The process of traditional fashion product distribution (“from producer to final user”) included presentation, encouragement and subsequently high-pressure selling to the consumer of designers’ and manufacturers’ deliverables. Within the context of high-responsiveness concept, fashion product is designed and manufactured on the basis of mass-market customer, rather than designers’ offers. Technologies of necessary precise information collection are now playing the decisive role in operation of marketing departments, dealing with all categories of brand fashionable clothes, as well as in operation of mass media, highlighting the fashion and trendy clothes industry issues.

Producers of fashionable clothes within the American mass market accepted the emerging high-responsiveness concept as another logistics manifestation and prognosticated its significant role in the fashion business transformation and departure from design-oriented approach as a primary aspect of trendy clothes industry [5]. Nevertheless, the consequences of introducing fast-fashion within the global trendy clothes market appeared to be far more serious. In spite of the fact that companies, engaged in the present market segment, are satisfied with all the advantages offered by «fast fashion» (gain in sales, profit enhancement, warehousing expenditures reduction, sales season cut-down), they are forced to be subject to continuous change and production of new product keep pace with modernizations in the sales sphere and to fully fulfil the consumers’ demand within the framework of intense competition. Consequently the project component of their fashion product goes behind as regards of its innovativeness, causing serious concerns of brand networks owners.

3 RESULTS AND DISCUSSION

The core aspect of high-responsiveness concept is constant image change within the context of fashionable tendencies. The most significant external criteria of the concept success was monthly or even weekly, rather than season-based renewal of clothes, as a fashion product, within the fashion market. It resulted in drastic reduction in fashion product life-cycle and its multifold recurrence in the life of short-term changing trend tendency [4].

All the abovementioned may be explained by the central motto of «fast-fashion» concept – timely satisfaction of consumers’ demand for fashion product at affordable prices. In other words the high-responsiveness concept has overwhelmingly invaded the mass market segment. Currently the active «fast-fashion» concept advancement is traced in those market segments, the consumers of which as regards of their attitude to fashion do not belong to conservatives or those falling behind time, but are strongly fashion conscious. Namely these consumers’ categories are more often subject to provocation as regards of outfit renewing. Low cost and constant rotation of hot items in sales outlets allow timely and cheaply copying the image and character, offered by designer brands within the elite fashion market segment [6].

The main principles of fashion business entities work within the «fast-fashion» segment are as follows:

- Fashion product release in small batches, frequent renovation of models pursuant to up-to-date tendencies
- Limited circulation of each fashion piece model in order to emphasize its exclusiveness and therefore status value
- Frequent assortment renewal of fashion product in sales outlets (2-4 times a month)
- Short-term sale of fashion product in sales outlets, what allows minimizing the necessity to introduce the sales season for fashion product

The key aspect of high-responsiveness concept is considered to be the shopping agiotage, triggered by an extremely limited circulation of highly fashionable pieces, accessible to mass consumer.

Such a strategy lead to the situation, in which the fashion product is capable of satisfying the needs of mass shopper all the more so, as the repeated circulation of each model is unreasonable and, consequently, hardly probable. The described situation only contributes to high-responsiveness concept strong penetration into shoppers' minds, creating the illusion of adherence to fashion product of «prêt-a-porte de luxe» class, having the same limited and unrepeated circulation.

The shopping agiotage is also strengthened by advertising and show technologies widely used within the sector under consideration: merchandising, PR-events, etc.)

Namely the speed of trademarks' response to changes in fashion tendencies, as well as adequate fashion product assortment correction (within the framework of commercial availability) attract mass-market customer, especially of those from metropolitan cities with its rapid speed of life supporting the spirit of trendy clothes change.

In close relation with fashion business high-responsiveness concept the «just-in-time» concept has emerged. The main essence of the concept is that the row stock and material used for clothes production (especially under conditions of constant assortment change and new clothes production in small batches) are supplied to manufacturing plant right up to beginning of the production cycle, reducing the warehousing cost to minimum.

Consequently, companies, engaged in the factory-supplied and retail brands segments, do not simply renew the fashionable clothes assortment, they change the approach to its creation in order to comply with and satisfy the needs of mass-market customer. This being the case, previously about 80% of all the fashionable clothes assortment was covered by the «primary usage» items, and only 20% were targeted at production and sale of assortment, subject to up-to-date tendencies. By today the priorities have changed, and namely the trendy assortment is regarded as of paramount importance by the companies, working in high-responsiveness concept stream. "Fashion capsules", formed on the basis of artistic and stylish themes of current trendy tendencies constitute the basis for assortment development and collections design.

As a result the trendy clothes collections in sales outlets are constantly renewed fostering the feeling of need to get the newest fashion piece, thus enhancing the customers' demand and shopping agiotage. Accordingly, such a swift circulation of fashion product in retail stores contributes to change of customers' attitude towards fashion and own needs. The term of wearing trendy clothes has educed to minimum, in the long run making the fashionable outfits "single-use" items. The main aspects of successful functioning of fast-fashion high-responsiveness concept within the fashion business are represented at Figure 1.

By reference to the fact, that fast-fashion concept needs the complete coverage of mass-market customer in the shortest time possible, the factory-supplied and especially commercial brands, engaged in the segment, were named «network brands». The name is derived from the sale approach – fashionable clothes of these companies is usually sold in widely represented trading network, embracing mono- und multi-brand shops [1].

If characterizing the notion network brand pursuant to the same criteria as other fashion business brands, it will meet all the unique qualities of «brand» - personalized name, trade mark, symbols and other identity elements, vital for authentication of the trendy product, produced by the brand. As regards of specific network brands factors, they are highlighted in Table 1.

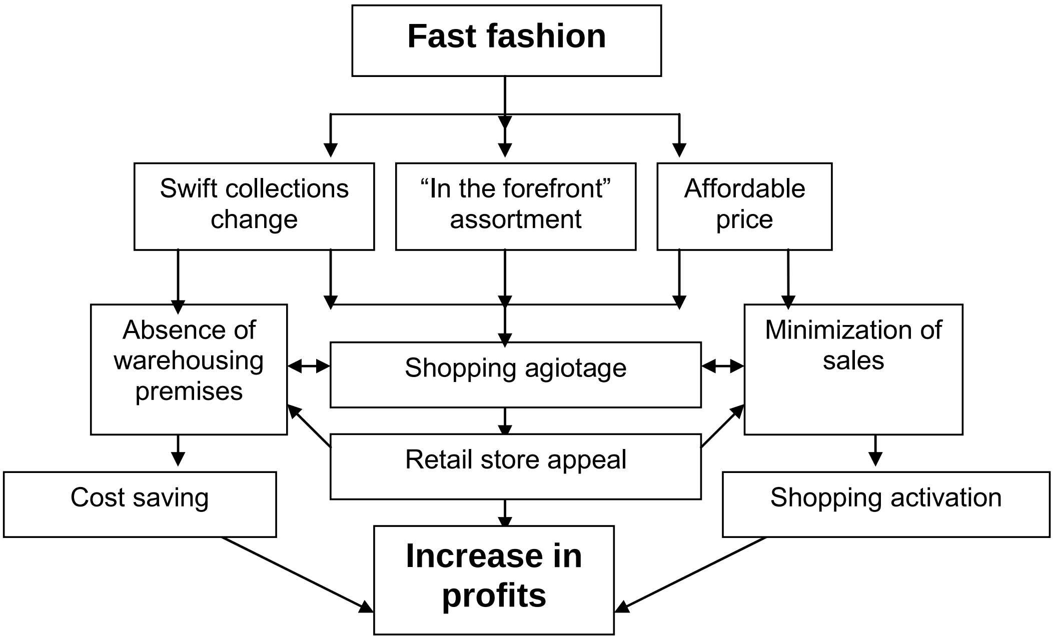

Figure 1 Key elements of fast fashion concept

Such an aggressive world fashion market occupation policy of factory-supplied and retail brands leads to paradox in the fashion world. High fashion houses, owning designer brands and «de luxe market», create fashion, develop up-to-date project characters and modern tendencies and foster their advancement in society with the help of mass media, advertising and show technologies, forming fashion standards in the society. On the other hand as soon as it comes to obtaining the commercial satisfaction due to advancement and sales of own ideas the mass market appears to be full of fashionable product in the fast-fashion incarnation. The designer brands speed up to create new modern tendencies and standards in order to keep regular customers' and mass media attention. Nevertheless the creators of designer brands with ever increasing frequency have to accept the tendencies, originating in mass fashion. Colin McDowell in his book "Designer tricks", discussing the significance of catwalk and other forms of fashion tendencies presentation, has stated: "Namely here the newly-designed product are approbated. Companies, selling clothes for mass consumer, cooperate with wide ranges of agencies, creating fashion trends for two-three seasons ahead and copy the haute couture models, patterns and interweavings, adapting them for cheap product market. This is a real role of haute couture in trade: manifest the new trends for color, fabrics and accessories" [7].

Similar cyclical nature of different brand existence within the consumers market forces the designer brands to correct the directions of their activities. In such a way the fashionable clothes lines for different target consumer audience (for example, Fashion House DIOR is releasing three diffuse outfit lines: woman prét-a-porte MISS DIOR, children BABY DIOR and manprét-a-porte CHRISTIAN DIOR MONSIEUR) is appearing. Furthermore, the world fashion market is witnessing activation in sale of licenses for the use of Fashion Houses names on conspicuous consumption items, not related to clothing (Pierre Cardin is the founder of the tendency); famous designers expand the sphere of their activity to other design fields (interior decoration, jewelry, designing of textile products, etc.).

Table 1 Factors and characteristics of world brands in fashion business

Factors	**Characteristics**
1	2
Seasonality	Minimum six collections a year provided that world fashion-calendar dictates extremely tight deadlines for designing, production, advertisement and sale of season collections
Role of brand-manager in shaping the brand	Shaping of fashion-tendency, support of clothes stylistic uniqueness, participation in designing the season program of marketing communication of the brand are included into professional duties of brand-manager
Flagship stores	Traditionally the network brands are sold either in own shops or through the system of franchising agreements with dealers, specifying seasonal volumes, procurement terms, requirements to retail space arrangement, terms of collection supply. An important tendency lies in creating so-called flagship stores, being the quintessence of aesthetic philosophy of the brand and creating unique shopping atmosphere
Positioning	Uniqueness of network trade mark is determined by sharply outlined position in comprehending the target audience, rather than by style, form and color of the fashion product
Balance of models and accessories	Possibility for the customer to create Total Look (stylistically shaped project image of the customer), i.e. be dressed from head to foot in one “designer” brand

4 CONCLUSIONS

Pursuant to the results of the carried out analysis it is worth mentioning, that the experience of fashionable outfit mass consumption proves the necessity of constant change in fashion standards and patterns, constituting the fashion main scope of activities. It depends namely on consumers and manufacturers of trendy product whether the fashion industry will be fully represented within the mass market. Sophistication of production technologies and modernization of manufacturing equipment constitute a significant background for the speed of fashionable outfit renovation. It allows producing more trendy clothes in shortest time, as well as reducing the product price due to use of automatization and global differentiation of labor within the production process. Correspondingly, the analysis of expenses on materials, time spent for product designing, as well as production expenditures constitute the key criteria of efficient fashionable outfit design within the framework of fast fashion concept.

Nevertheless, the most successful approach is the consolidation of creative ideas of High Fashion Houses’ designers and stylists, offering trademarks and factory-supplied brands within the fast-fashion segment. Developers of designer brands gain large-scale involvement and availability of fashion product, and, consequently, tonnage media and wide marketing network. On the other hand with their names they provide the mass consumption trendy outfit with the hint of exclusiveness, resulting in limited circulation, constrained representation in the sales outlets and boosting of product price. The present tendency of collaborations shaping is developing both actively and in diversified direction and may become the starting point for a new concept of fashionable innovations distribution in future.

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