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RESEARCH REGARDING THE INFLUENCE OF CHEMICAL FINISHING PROCESSES ON THE THERMOPHYSIOLOGICAL COMFORT OF FABRICS

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Abstract: *Due to "insensibilis perspiration" process of the human body, the textile materials for the garment products, must have vapour permeability. In order to feel the thermo physiological comfort during clothing wear, the vapour permeability values must be correlated with the environment, the body conditions and factor related to the fabrics (finishing treatments, structure, raw materials).Vapour permeability capacity through fabrics are important properties of fabrics that influence the comfort of thermo-physiological products for apparel products. Chemical finishing processes applied to textile materials can improve or reduce the vapour permeability capability depending on the destination. Textile dyeing and film finishing processes influence the vapour permeability and implicitly, the other thermophysiological comfort features (air permeability, thermal insulation) that determine the use of a textile fabric.The paper presents the results of the researches realized on samples of fabrics with different structures, made from polyester yarns in the warp system, with different length densities. The purpose of the research is to emphasize the influence of chemical finishing processes (dyeing and waterproofing through film coating) on vapour permeability values. The experimental values obtained for vapour permeability as well as the calculated coefficients of vaporization, as a direct indicator of this thermo physiological comfort feature, have allowed the determination of the range of use of the analysed fabrics.*

Keywords: *fabrics, yarns, polyester, water vapour permeability, finishing processes*

1. INTRODUCTION

The scope of use of a fabric, requires the analysis of specific characteristics [5, 3]. Thus, fabrics for curtains, roller shutters, blinds, high moisture protection clothing (for the army, police, fire brigade, gendarmerie, or for emergency response personnel) must meet, in addition to mechanical and aesthetic properties, a series of comfort properties such as: vapor permeability, air permeability, hygroscopicity, etc. Painting and coating treatments change the values of these features. In order to meet the requirements of the field of use, the fabrics analyzed are double acrylic layer coated. Are studied the permeability to water vapour through the fabrics, made of polyester yarn with different lengths densities, in different stages of chemical finishing (painting and double acrylic layer coated) [1, 2, 3, 4].

2.EXPERIMENTAL METHOD

The present research used three variants fabrics with polyester yarns, with different length densities in the warp and the weft (table 1).

The fabrics variants were denoted: V_{11} - Raw fabric;V_{12} - Painted fabric;V_{13} - Fabric coating; V_{21} - Raw fabric;V_{22} - Painted fabric;V_{23} – Fabric coating ;V_{31} - Raw fabric;V_{32} - Painted fabric;V_{33} - Fabric coating.

Table 1: *Experimental variants of fabrics*

Fabrics variants V_i		**Yarn characteristics**		**Density [yarns/cm]**	
		Warp Rotoset polyester yarns	**Weft** Rotoset polyester yarns	**Warp [yarns/cm]**	**Weft [yarns/cm]**
V_1	V_{11}	Tden=150den	Tden=300den	38	19
	V_{12}				
	V_{13}				
V_2	V_{21}	Tden=75 den	Tden=75 den	38	30
	V_{22}				
	V_{23}				
V_3	V_{31}	Tden=150x2den	Tden=300 den	19	19
	V_{32}				
	V_{33}				

* i - fabric option; j – finishing variant chemical fabric

The research studied fabrics made of polyester yarns set and rotoset with different densities of length, for outdoor clothing waterproof. All fabrics are quilted fabric and bond have made in two variants of number of yarns per unit length in the warp and two variants of number of yarns per unit length in the weft. In table 1 shows the main characteristics of the studied fabrics. Determination of the water vapour permeability of fabrics is carried out in accordance with STAS 9005/71 [5, 6].

3.RESULTS AND DISCUSSION

The experimental values of relative permeability P_v [g], absolute permeability P_{va} [%] and the calculated values of the evaporation coefficient μ [g / m^{2}h] are presented in tables 2, 3.

Table 2: *The experimental values of water absolute vapor permeability P_{va} [g] and relative values of water permeability P_v [%]*

The cod of fabricsV_{ij}*	**The absolute vapour permeability Pva [g]**			**The relative vapour permeability Pv [%]**		
	Pva_{24} [g]	**Pva_{48} [g]**	**Pva_{72} [g]**	**Pv_{24} [%]**	**Pv_{48} [%]**	**Pv_{72} [%]**
V_{11}	1.18	2.431	3.480	0.945	1.947	2.786
V_{12}	1.283	2.709	3.383	1.204	2.543	3.635
V_{13}	0.523	1.082	1.568	0.428	0.885	1.283
V_{21}	1.062	2.279	3.316	0.831	1.784	2.596
V_{22}	1.283	2.612	3.736	1.036	2.109	3.016
V_{23}	0.526	1.075	1.561	0.447	0.913	1.326
V_{31}	1.060	2.213	3.230	0.741	1.546	2.257
V_{32}	1.176	2.461	3.556	1.103	2.307	3.334
V_{33}	0.620	1.262	1.828	0.466	0.948	1.373

Table 2 shows that the vapour permeability values of dyed fabrics, regardless of the fabric version, are bigger in comparison with the raw and coated fabrics.

In fhe fig.1 are presented the values of absolute vapour permeability for 9 fabrics variants using the values from table 1.

The dyed fabrics variants have, depending on the exposure time, a vapour permeability absolute value bigger than raw fabrics coated fabrics (table 2, fig.1) .

The V_{22} fabrics have vapour permeability bigger with 15,4% to 19.8% than V_{21} raw fabrics and with about 56,4% and 56,7% than V_{23} coated fabrics.

The dyed fabrics from V_{31} variant, have vapour permeability values bigger with 58,8% to 58.9% than coated fabrics from V_3 variant, depending the exposure time.

Regarding the vapour permeability variation at the 24 hours exposure time, the values of vapour permeability from dyed fabrics V_1, are bigger with about 8,39% than dyed fabrics V_3 and are bigger with 13,95% than V_2 variant.

Table 3: *Calculated values of vaporisation coefificint μ [g/m^2h]*

Cod V_{ij}^*	**Evaporation coefficient μ[g/m^2h]**		
	μ_{24} [g/m^2h]	**μ_{48} [g/m^2h]**	**μ_{72} [g/m^2h]**
V_{11}	17.389	17.912	16.618
V_{12}	18.907	19.961	17.094
V_{13}	7.707	7.972	7.702
V_{21}	15.650	16.792	16.289
V_{22}	18.907	19.246	18.352
V_{23}	7.751	7.921	7.668
V_{31}	15.620	16.306	15.866
V_{32}	17.330	18.133	17.468
V_{33}	9.137	9.299	8.979

The dyed fabrics variants V_{12} have a permeability value bigger with 64,5% to 65,2% then coated fabrics (fig.1, fig.2, fig.3, fig.4, fig.5).

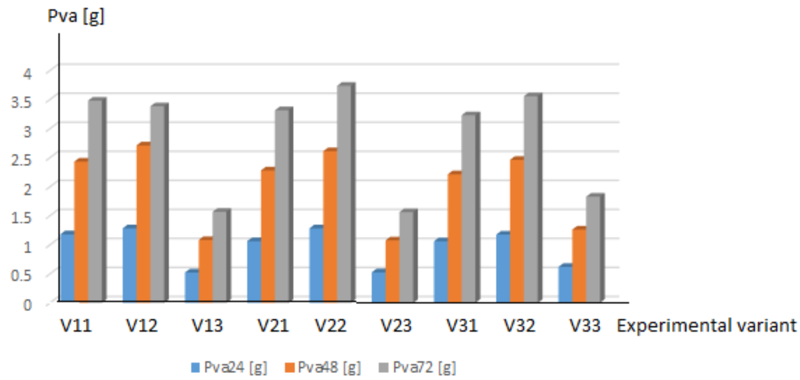

Fig.1: *Histogram of absolute permeability values*

The relative values of vapour permeability are presented in fig.2 as histograms in order to be analysed in comparison between different fabrics variants.

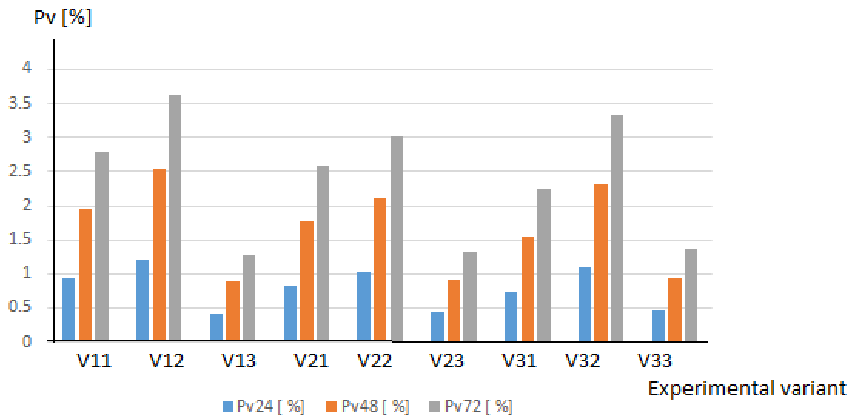

Fig.2*: Histogram of relative permeability values*

Fig.3, fig. 4 and table 2 show that the values of vapour permeability at 72 hours , grows from coated fabrics to raw fabrics.

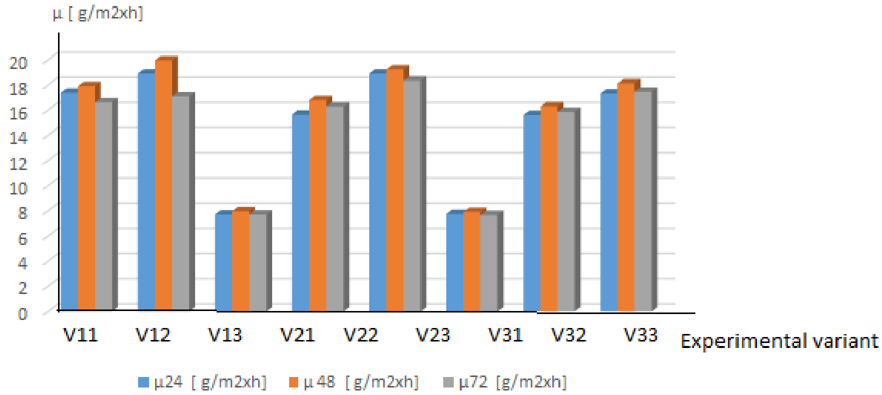

Fig.3*: Histogram of evaporisation coefficient values*

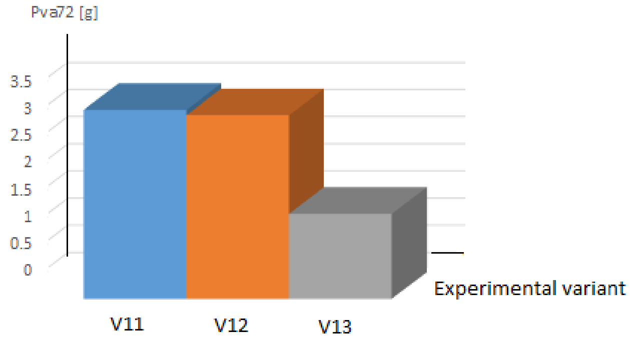

Fig.4 *: Histogram of permeability values at 72 hours for V_1 fabric variant*

After analyzing the time variation of the vapour permeability it was obtained a graphic as that from fig. 5. From this figure it can see that there is a linear variation between vapour permeability and time. The eqation for raw fabrics is y=1.1773x and the corelation coefficient is R^2=0.9968 which represents a strong corelation.

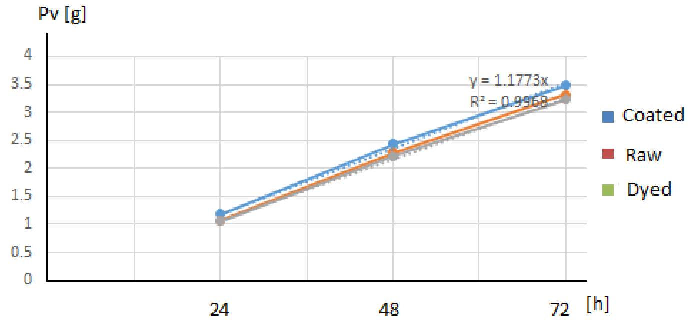

Fig.5: *The variation in time of vapor permeability for V_1 fabric*

The V_{32} variants have a vapour permeability bigger with 32,3% to 32,8% than raw fabrics $V_{31.}$

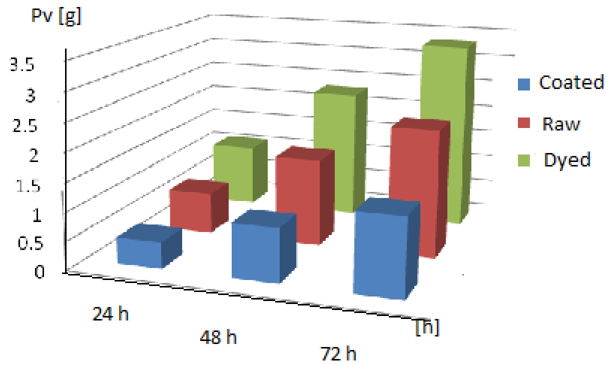

Fig. 6: *The vapor permeability for V_{31}, V_{32}, V_{33} fabrics variant*

The raw fabrics from V_1 variant have values for vapour permeability with 12.06% bigger than raw fabrics from V_2 variants and with 21,59% than raw fabrics V_3 variants (fig. 6). The coated fabrics V_3 have a vapour permeability bigger with 8.15% than V_1 variant and with 4.08% than coated fabrics variants V_2. At 48 hours, the vapour permeability of raw and dyed fabrics from V_1 variant is bigger than V_2, V_3 variant.

At 48 hours, the vapour permeability of raw fabrics and dyed fabrics from V_1 variant is bigger than V_2, V_3 variant and the coated fabrics variants have smaller values of vapour permeability. At 72 hours the vapour permeability values of V_1 variants are bigger than vapour permeability of V_2 and V_3 variants. The difference between the vapour permeability values are bigger at raw and dyed fabrics ant insignifiant for coated fabrics.

Fig.3 and table 2 show that the evaporation coefficient values range between 17,094 g/m^{2}h and 19,961 g/m^{2}h for dyed fabrics and between 16.618 g/m^{2}h and 17,912 g/m^{2}h for raw fabrics. At coated fabrics, the evaporation coefficient values are between 7,702 g/m^{2}h and 7,972 g/m^{2}h.

For dyed fabrics the evaporation coefficient values are bigger with 2,78% to 10,2% than raw fabrics depending the exposure time. So, the evaporation coefficient grows with 5.3% up to 48 hours for dyed fabrics and with 2.92% for raw fabrics. The values of evaporation coefficient fall within the range 48 hours and 72 hours for dyed and raw fabrics variants, as a result of a saturation phenomenon of the fabrics with vapours.

For V_2 dyed fabrics variant the values of evaporation coefficient are bigger with 58,2% to 59%, than those coated fabrics and with 12,75% and 17,23% than raw fabrics (table 1).

The evaporation coefficient for V_3 fabrics variants is bigger with 47,28% to 48,72% than coated fabrics and with 9,17% to 10,08% than raw fabrics from V_3 variant.

The values of evaporation coefficent of dyed fabrics are bigger than raw and coated fabrics. So, after 24 hours, the dyed fabric have evaporation coefficient values between 17,330 [g/m^{2}h] and 18,907[g/m^{2}h], the raw fabrics between 15,650[g/m^{2}h] and 18,907[g/m^{2}h] and the coated fsabrics between 7,707[g/m^{2}h] 9,137[g/m^{2}h].

The differences between evaporation coefficient values for V_1, V_2 and V_3 fabrics are relative small and the variation is between 8,34% and 10,17%.

4. CONCLUSIONS

The textile fabrics with technical destination are frequently used due to their diversity and complexity.

The paper presents the results of research regarding the vapour permeability of that are fabrics dyed and have coated treatments.

Take into consideration the results, it can concludes that the coated fabrics analyzed in this paper can be used for waterproof clothing

The research has been targeted on three fabrics with different structures (V_1, V2, V_3) (table 1) on three textile finishing ranges (raw fabrics $V_{i1,}$ dyed fabrics V_{i2} and coated fabrics with two acrylic layers V_{i3}).

It was experimentally determined the vapour permeability (relative and absolute values) and were calculated the values of evaporation coefficient as direct indicator for fabrics behaviour at vapour transfer.

The values for vapour permeability of V_1 fabrics are bigger than for V_2 and the V_3 fabrics variants.

The dyed fabrics in different variant has the biggest values for vapour permeability.

The evaporation coefficient has the smallest values for dyed fabrics from V2 variant (17,094g/m^{2}h and18,907g/m^{2}h).

Textile dyeing and film finishing processes influence the vapour permeability and implicitly, the other thermophysiological comfort features (air permeability, thermal insulation) that determine the use of a textile fabric.

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