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Investigations upon properties of solvent and dispersion adhesives for upholstery furniture production. Part I. Wettability and hardness of the solidified layers

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Abstract: *Investigations upon properties of solvent and dispersion adhesives for upholstery furniture production. Part I. Wettability and hardness of the solidified layers*. For solidified layers from upholstery adhesives, formed on the glass surface was determined the contact angle and was designated the free surface energy together with dispersion and polar shares and evaluation the relative hardness was executed. Measurement of the contact angle was carried out with the biological microscope with the goniometrical equipment, however the relative hardness with the Persoz pendulum appropriately after the period of 24, 72, 168 and 336 h of conditioning time of samples (20±2°C, 65±5%). On the basis of results of research, it was stated among others, that in the function of conditioning time followed the growth of the relative hardness of layers. This dependence was most intensive for the Jowatac 456.34 adhesive at applying with thick liquid layer 90 μm. In case of the greater quantity of applying the consolidation process of the adhesive ran slow down. Values of the free surface energy were better for solvent adhesives and were shaped within the range from 57 mJ/m^2 (for 456.34 [90 μm]) to 61 mJ/m^2 (456.56 [210 μm]), and for dispersion adhesives appropriately for 1C 44.35 mJ/m^2 and 35.05 mJ/m^2 for 2C.

Keywords: solvent adhesive, waterborne adhesive, upholstery furniture, adhesive layer, wettability, relative hardness

INTRODUCTION

For the years was notes down the dynamic development of upholstery furniture, in which flexible parts of seats and supports of chairs, armchairs and couches, consisting usually from several layers fulfilling different functions require uses of many materials among other things such as of foams, fizelins, jutes, upholsterer's cotton wool, and leather. Due to the layered construction of upholsterer's arrangements one of more important components, decisive chiefly about the cohesion and strength of furniture are adhesives (Bernaczyk & Proszyk 1995, Proszyk 1996, Anonymous 2010). According with EU Directives recommends the application of binding agents about the limited content of solvents or waterborne systems. In practice domineer solvent adhesives in the High Solid version (solid content 60-70%), Super High Solid (75-85%), and dispersions in 1C or 2C versions (50-60%) or hot melt adhesives (Louven 2008, Proszyk 2009, Anonymous 2011).

The market offer of adhesives to the upholstery furniture production is very rich, what creates producers wide possibilities of the choice, having especially on the attention application characteristics and parameters of obtained connections (Hilbrath 2000).

It requires, so that adhesives perfectly joined porous surfaces, not causing at this of the excessive stiffening of boundary layers. The hardness of solidified adhesive layers has a huge influence on the properties of resultant connections. Layers about the suitable elasticity provide because otherwise the dimensional stability of upholstery elements and expected ergonomic functions. In the above context was undertook the work about the experimental character, whose a cognitive aim was the definition on the basis of assumptions of adsorption theory of adhesion and measurement of the contact angle on the course of surfaces forces of adhesive layers together with dispersion and polar shares. Furthermore the relative hardness was examined, with being expressed of the cohesion forces of tested layers.

EXPERIMENTS

For the realization of the experimental part, 2 solvent adhesives appropriately Jowatac 456.34 conventional, and Jowatac 456.54 HS, and 2 dispersion product in 2C version Jowatac 414.10 together with the 414.80 hardener and 1C Jowatac 414.50 were chosen. Solvent adhesives were applied with the use of the applicator (90 and 210 μm) on glass plates with dimensions 100 x 100 mm. However dispersions adhesive were applied in the two layers form in productive conditions with the spraying method.

Measurements of the contact angle Θ the surface of adhesive layers for the distilled water as wetting liquid acc. to PN-EN 828 standard were carried out. Water was applied with the chromatographic syringe in the form of drops with the volume 3.5 μl and after lapse 10 s measurements the contact angle with the specialistic microscope with the goniometrical equipment were performed. On the basis of averaging data given from 10 measurements, values surface free energy (γ_S) together with dispersion and polar shares acc. to Neumann & Sell (1967) and Liptáková (1980), and the dispersion and polar shares acc. to Kloubek (1974) were calculated.

However to describe the relative hardness of adhesive layers was applied the research procedure described in PN-79/C-81530 standard, using the Persoz pendulum, for which the glass constant carried out 480 oscillations. For everyone investigated binding agents was prepared for 3 samples, on which was executed 8 measurements.

Both measurement of the wettability, as and hardnesses of adhesive layers were performed in the function of conditioning time (20±2°C, RH 65±5%), appropriately after the period time 24, 48, 72, 168 and 336 h.

RESULTS

In the Table 1 was presented the course of relative hardness of layers from expressed as number of oscillations of pendulum, taken into account in experiences of adhesives after the lapse of 336 h of conditioning.

Tab. 1 The course of relative hardness of adhesive layers after 336 h conditioning

Kind of adhesive	**Amount of application [μm]**	**Number of oscillations [-]**
456.34 (solvent)	90	74
	210	75
456.54 (solvent)	90	17
	210	10
1C (dispersion)	-	35
2C (dispersion)	-	20

Generally it was stated, that in the function of conditioning time of layers had appeared the tendency of the growth of analysed parameter. Maximum values (0.185) were noted down for the solvent Jowatac 456.34 adhesive at the application in the quantity 210 μm and Jowatac 456.34 at drifting 90 μm (0.160). While lowest results were registered for the 456.54 binding agent, for which the hardness was formed on the level 0.036 for 90 μm and 0.016 for 210 μm.

Values of the contact angle (θ) of the surface layers after the lapse of time 336 h was illustrated on the fig. 2. Obtained results were characterized with the large repeatability, what found a reflection in the low value of the variation coefficient which in general, did not exceed 6%.

Tab. 2 Comparison of the contact angle values of obtained adhesive layers after the lapse 336 h of the conditioning time

Kind of adhesive	Amount of application [µm]	Contact angle [deg]
456.34 (solvent)	90	37.23
	210	40.81
456.54 (solvent)	90	43.52
	210	44.21
1C (dispersion)	-	65.25
2C (dispersion)	-	81.83

The general analysis of obtained data proves, that with the lowest contact angle θ were characterized surfaces of layers from the solvent Jowatac 456.34 adhesive (37.23 deg) at the application carrying out 90 µm. However for the adhesive dispersion 2C Jowatac 414.10 + 414.80 was noted down the maximum value of this parameter 81.83 [deg]. Results obtained for measures binding of solvent placed themselves on level 40 [deg], however for of dispersion product was registered clearly higher values, exceeding this value suitably about 50% (for the product 1C) and about 100 % (for 2C).

In turn values of the free surface energy of layers from adhesives after the lapse 336 h of conditioning time were shaped for solvent adhesives within the range values from 56.67 mJ/m^2 (for 456.34 - 90 µm) to 60.52 mJ/m^2 (456.56 - 210 µm), and for dispersion appropriately 1C - 44.35 mJ/m^2 and 35.05 mJ/m^2 for the 2C system. To mention, that in case of solvent adhesives values of dispersion and polar shares they were comparable, however for waterborne adhesives was found the greater participation of the dispersion (approx. 85 %) share.

CONCLUSIONS

1. In the function of conditioning time followed the growth of the relative hardness of layers. This dependence was most intensive for the Jowatac 456.34 adhesive at drifting 90 µm. In case of the greater quantity of applying the consolidation process of the adhesives ran slow down.
2. Values of the free surface energy of layers from tested adhesives were different and for solvent adhesives were shaped within the range of values from 56.67 mJ/m^2 (456.34 - 90 µm) to 60.52 mJ/m^2 (456.56 at 210 µm), and for of dispersion appropriately for the 1C system 44.35 mJ/m^2 and 35.05 mJ/m^2 for 2C. In case of solvent systems values of dispersion and polar shares were comparable, however for of dispersion was found the greater participation of the dispersion share.

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Streszczenie: *Badania właściwości klejów rozpuszczalnikowych i dyspersyjnych przeznaczonych do produkcji mebli tapicerowanych. Cz. I. Zwilżalność i twardość zestalonych warstw*. Dla zestalonych warstw z klejów tapicerskich, uformowanych na powierzchni szkła określano kąt zwilżania (Θ) oraz wyznaczono swobodną energię powierzchniową wraz ze składowymi dyspersyjną i polarną oraz dokonywano badań twardości względnej. Pomiary kąta zwilżania przeprowadzono mikroskopem biologicznym z przystawką goniometryczną, natomiast twardość względną wahadłem Persoza odpowiednio po upływie czasu 24, 72, 168 i 336 h klimatyzowania próbek w warunkach RT i RH. Na podstawie rezultatów badań, stwierdzono m.in. że w funkcji czasu klimatyzowania następował wzrost twardości względnej warstw. Zależność ta była najintensywniejsza dla kleju 456.34 przy naniesieniu 90 μm. W przypadku większej ilości naniesienia proces konsolidacji kleju przebiegał wolniej. Wartości swobodnej energii powierzchniowej były korzystniejsze dla klejów rozpuszczalnikowych i kształtowały się w zakresie od 56,67 (456.34 [90 μm]) do 60,52 mJ/m^2 (456.56 [210 μm]), a dla dyspersyjnych odpowiednio dla 1K 44,35 mJ/m^2 i 35,05 mJ/m^2 dla 2K.

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