Selection criteria of lacquer composition on wood surfaces from aqueous dispersions of acrylic polymers

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Introduction

Polymer dispersions, including dispersions of acrylic copolymers are an important component to produce the thin-film materials such as paints and varnishes.

Use of aqueous polymer dispersions as film-forming substances in the painting materials can largely solve the environmental problems, and also significantly reduce the value of painting material. The acrylic dispersions, emulsions alkyl, polyurethane dispersions and polyurethane-acrylic dispersions are used as a binder for advanced coatings for wood components. Due to the chemical resistance, resistance to external conditions and the diversity of mechanical properties of acrylates are often used in the dispersions in wood chemistry. Selection of relevant components of paint is essential in the application process. Depending on the manner of applying the varnish composition must have a suitable viscosity [1-6].

Considered compositions were selected for the application of applications such as air spray mix, airless, electrostatics. The selection method is conditioned by a kind of painted pieces of wood. This gives a good quality paint coat, uniformly applied across the element. The process of creating protective coatings from aqueous polymer dispersions consists in combining the particles of disperse phase with simultaneous removal of aqueous environment and create a watertight coat.

It is known that not all polymer dispersions in the air-dry at room temperature (about 20°C) are capable of forming a homogeneous dense coat. This ability have only dispersions in which the polymer is in the highly plastic and viscous state, above the glass transition temperature of the polymer [7].

Thus, a very important parameter of the product is the drying time lacquered coat. The coating is formed by physical evaporation of volatile components (water and coalescing solvents.) The quick drying process causes to obtained a coating with good properties. To create the lacquer paint on the wood takes place at room temperature. In the case of coatings applied to wood, is very important to the ability to penetrate into the structure of wood adhesives. Therefore it is important to choose the correct components to produce the ideal lacquer coat. Tested compositions were applied to paint wooden elements, such as chairs and furniture box [8-9].

Experimental

Materials

- water -based acrylic resin „AC 2514", dry weight 42-44%, viscosity 30-300 mPas, pH 7-8, MTTF = 43°C Koenig hardness = 105 s Alberdingk Boley product
- polyurethane thickener „Cognis DSX 1514", „Cognis DSX 3290", Cognis product
- kaolin inorganic thickener„ASP170" grain size 0,4 μm. Basf product,
- inorganic thickener montmorylonit „Opitgel CL" and „Optigel WA", mineral clay, good water adsorption properties
- koalescent metoksydipropanol (glycol monomethyl ether, di propylene) boiling point 190°C, density 0,899-0,904 at 20°C good water miscibility, Brenntag Poland distribution
- koalescent „Solvenon DPnB" (n-butyl ether propylene glycol di), boiling point 229°C, density 0,9-0,92 at 25°C BASF product
- koalescent „BG" (ethylene glycol butyl ether), boiling point 170°C, density 0,899-0,904 at 20°C unlimited water miscibility, Brenntag Poland distribution
- dampers: „Byk333" (polydimethylsiloxane polyether), „Byk 349" (polyether siloxane),measures to improve the coating smoothness and resistance to sticking, BYK Chemia product
- dampers „Wet 270", „Wet 280" (polyether siloxane copolymers), highly efficient, prevention of craters, Evonik Tego Chemie product
- damper „SilcoFLWK-134" (polyether siloxane copolymers), highly efficient, improving the flow and leveling, Silcona product
- defoamers measures „ Airex 902W", „Airex 902W", „Foamex 820", „Drewplus TS4481", (polyether siloxane copolymers), prevention of micro and macro foam, Evonik Tego Chemie and Ashland product
- matting agent, „Acematt 520" (silica), grain size 6,5 μm, Evonik Industries product
- modified paraffin wax „Ultralube E359", „Ultralube D1312", smooth coating and water resistant improvement, KEIM-ADDITEC product
- fluorosurfaktant-zonyl, dirt resistant improvement, water and oil effect.

The research methodology of paints and coatings

- determining the viscosity of paints made according to PN-81/C-81508, measuring the flow time (s), cup with a discharge nozzle with a diameter of 4 mm
- determination of the hardness of the coatings using a pendulum according to PN-EN ISO 1522
- scratch resistance was measured according to PN-65/C-81527
- adhesion to wood and steel set according to PN-80/C-81531, performing a grid of cuts with a knife discoid Peters
- resistance test of paint coat to liquid according to PN-EN ISO 2812:2008.

Preparation of test samples consisted of two layers of the test application of varnish on dyed a dark color form will (beech veneer) or massive beech. Thus prepared, the material was subjected to drying at room temperature for 7 days and then conduct research involving the physical and chemical action of various fluids through the established periods of time. Assessment of the destruction of the coating was evaluated by the scale:

5 – no visible change

4 – slight change in gloss and / or colors, visible only under a certain angle of observation

3 – moderate change in gloss and / or color

2 – a clear change of gloss and / or color, without changing the surface structure

1 – damaged area, e.g. bladders partially or totally removed.

Preparation method of paints and coatings

Varnish composition was prepared by introducing into a vessel appropriate amounts of acrylic resin the others components (some of the components were prepared in advance and implemented in the form of impurities, which facilitated the way they dispense to the system).

The whole composition was dispersed using dissolver Disperlux Green 037th Mixing speed was 1200 rpm. within 45 minutes. Thus prepared paint was applied to the substrate metal and wood, and subjected to acclimation. The acclimation period lasted 7 days until completely dry the coat at room temperature. The resulting films were tested as described previously.

Test results and discussion

Tables 1÷3 contains selected paint compositions. The compositions in Tables 1÷3 have a high proportion by weight of acrylic copolymer AC 2514 in relation to other components of the dispersion.

Table 1

Selected water-thinnable acrylic compositions

The composition of dispersion	No 1 dispersion Wt %	No 2 dispersion Wt %	No 3 dispersion Wt.%
AC 2514	56.00	50.00	55.60
Metoksydipropanol	2.94	1.70	1.70
Solvenon DPnB	2.40	1.40	1.40
Foamex 810	0.20	0.20	0.20
Silco FLW 134	0.30	0.30	0.30
Demineral water	30.00	38.10	38.10
AMP 90	0.20	0.20	0.20
Acematt OK 520	0.60	0.60	1.00
Ultralube D 1320	6.00	6.00	-
Cognis DSX 1514	0.51	0.34	0.34
Cognis DSX 3290	0.60	0.52	0.56
Glide 482	0.20	0.20	0.20
Zonyl FS 610	0.05	0.30	0.30
Airex 901 W	-	0.05	0.05

Table 2

Selected water-thinnable acrylic compositions

The composition of dispersion No 4	Wt %	The composition of dispersion No 5	Wt %	The composition of dispersion No 6	Wt %
AC 2514	60.00	AC 2514	58,5	AC 2514	57.90
Metoksydipropanol	2.50	Metoksydipropanol	1.10	Metoksydipropanol	1.10
Solvenon DPnB	3.00	Solvenon DPnB	2.80	Solvenon DPnB	3.00
Silco FLW K- 134	0.40	Wet 280	0.30	Wet 280	0.31
Acematt OK. 520	1.70	Airex 901 W	0.05	Airex 901 W	0.07
ASP 170	12.00	Acemat ok. 520	0.50	Acemat ok. 520	0.50
Demin. water	20.10	Demin. water	24.00	Demin. water	23.00
AMP 90	0.10	Disperbyk	0.01	AMP 90	0.10
Byk 333	0.30	AMP 90	0.10	Optigel WA	0.80
Ultralube E359	8.00	Optigel WA	0.80	Optigel CL	0.80
Airex 901 W	0.05	Optigel CL	0.80	Metoksydipropanol	1.40
Butyloglikol	1.40	Metoksydipropanol	1.55	Cognis DSX 3290	0.71
Cognis DSX 3290	1.00	Cognis DSX 3290	0.69	Cognis DSX 1514	0.44
Tego Glide 482	0.30	Cognis DSX 1514	0.50	Ultralube E 359	8.00
Tego Airex 902 W	0.15	Ultralube E 359	8.00	Glide 482	0.32
		Glide 482	0.30	Airex 902 W	0.22
		Airex 902 W	0.24	AC 2508	4.60

Table 3

Selected water-thinnable acrylic compositions

The composition of dispersion No 7	Wt. %	The composition of dispersion No 8	Wt. %	The composition of dispersion No 9	Wt. %
AC 2514	62.50	AC 2514	62.50	AC 2514	62.50
Metoksydipropanol	2.00	Metoksydipropanol	1.50	Metoksydipropanol	0.60
Solvenon DPnB	2.70	Solvenon DPnB	1.50	Solvenon DPnB	0.63
Airex 901 W	0.10	Airex 901 W	0.05	Airex 901 W	0.15
Silco FLW K- 134	0.60	Byk 349	0.19	Byk 349	0.16
Demin. water	28.67	Demin. water	28.13	Demin. water	28.00
AMP 90	0.10	AMP 90	0.15	AMP 90	0.15
Metoksydipropanol	1.50	BG	1.70	BG	1.70
Cognis DSX 1514	0.38	Cognis DSX 1514	0.54	Cognis DSX 1514	0.77
Cognis DSX 3290	0.60	Cognis DSX 3290	0.88	Cognis DSX 3290	1.06
Acemat ok. 520	0.50	Acemat ok. 520	0.55	Acemat ok. 520	0.50
Airex 902 W	0.15	Airex 902 W	0.05	Airex 902 W	0.20
Glide 482	0.20	Glide 482	0.36	Glide 482	0.35
		BG	1.60	BG	3.10
		Drewplus TS4481	0.20	Wet 270	0.13
		Wet 280	0.10		

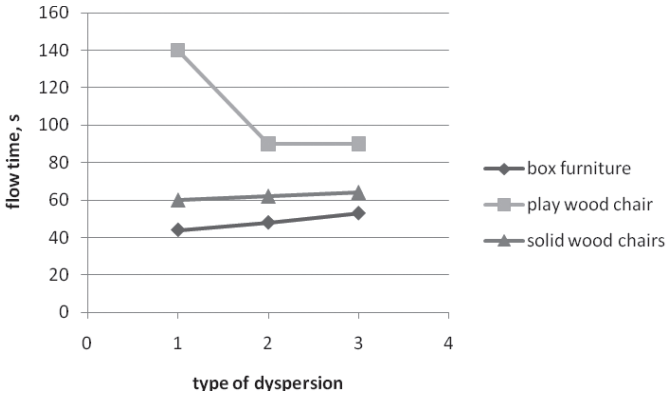

Fig. 1. Viscosity of acrylic paints measured in flow out cup according to PN-81/C-81508

The values of the relative viscosity water-based paints shown in the following tables are located in a wide range. From about 54 sec for the composition to the chairs of ply-wood to the difficult to measure the discharge of a cup of $\phi = 4$ mm high values from 70 to 145 for the composition of box furniture. Figure 1 shows the summary graphic of viscosity for acrylic composition.

The greatest adhesion (1) showed paint coatings obtained from table 1-3, after the cross-cut by PN-80/C-81531. Some variations of the properties investigated coatings were found while trying to scratch resistant coatings. The highest scratch resistance of paint coating showed the chair of plywood - no test 4,5 and 6, and a smaller scratch resistance coating showed the other compositions: box furniture and wooden furniture.

Analyzing the composition of each dispersion, these results correlate with the content of polymer binder and thickener in the coating. Scratch resistance is higher, the higher the aggregate content and thickener resin system. Figure 2 shows the scratch resistant coating.

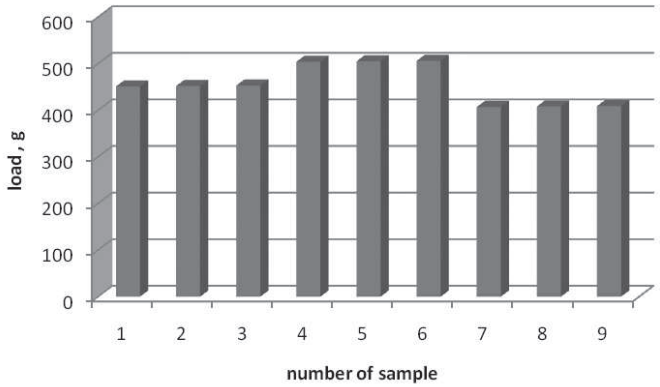

Fig. 2. Scratch resistance of acrylic coatings according to PN-65/C-81527 standard; no of paints as in Table 1÷3

The test results of liquids resistance showed that all tested coatings on wooden base had good properties. In some cases, visible changes were observed after the test coatings. The most devastating effect was with acetone for paint coat on furniture made of plywood, the sample No. 4,5 and 6 and the solid wood furniture, sample No. 7, 8 and 9. A clear change of gloss and color paint coat was in the case of coffee, tea and water on the surface of sample No. 1, 7,8 and 9. The edible oil was the least destructive on surface coating. The oil application did not induce any visible changes in the structure of all investigated coatings. The results of liquid resistance shows Table 4.

Table 4

Evaluation of coating resistance to liquids

Type of fluid	Upti-me	Degree of changes								
		No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Acetone	10”	3	3	4	5	5	4	1	5	5
Acetone	10’	3	3	4	1	1	1	2/1	2/1	5/4
Cif	16h	3	3	3	2	2	2	3	3	3
Spirit	16h	3	2	2	3	3	2	3/4	3/4	4
Boiling water	(po-ured)	2	5	5	-	-	-	-	-	-
Wine	16h	2	5	4	5	5	3	-	-	-
Caffee	16h	2	5	3	4	5	4/5	2	2	2
Tea	16h	2	4	3	3/4	3/4	3	2	2	2
Water	24h	2	4	3	5	4	4	2	2	2
Edible oil	24h	5	5	5	5	5	5	5	5	5
Cup of boiling water	1h	4	5	5	-	-	-	-	-	-

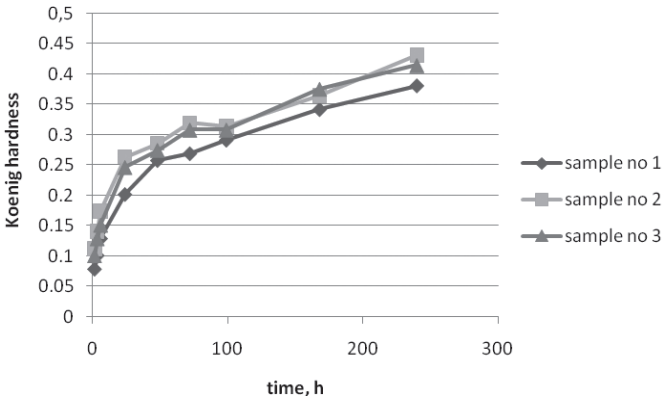

Fig. 3. Relative hardness of acrylic coatings according to PN-EN ISO 1522; no of sample as in Table 1

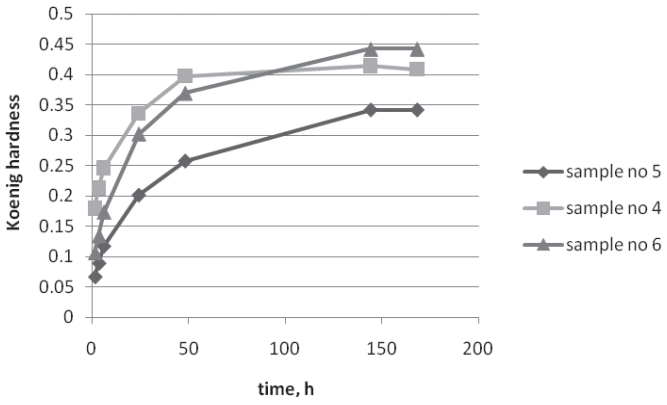

Fig. 4. Relative hardness of acrylic coatings according to PN-EN ISO 1522; no of sample as in Table 2

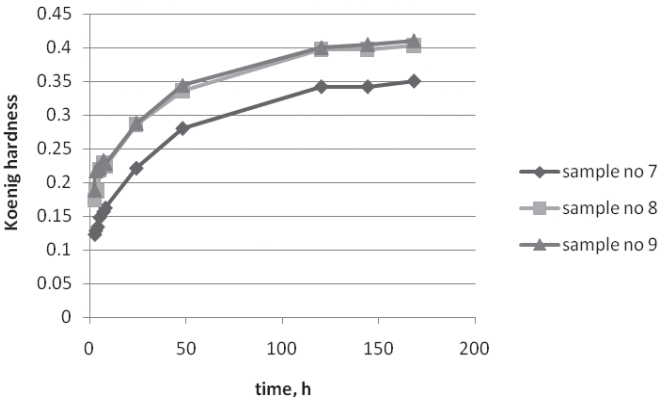

Fig. 5. Relative hardness of acrylic coatings according to PN-EN ISO 1522; no of sample as in Table 3

The results of coats hardness, samples 1-9, show that it is reasonable to use the inorganic thickeners such as kaolin and

montmorillonite, contained in the acrylic dispersion for furniture made of plywood. In the case of kaolin, sample No 4 and compare with sample No. 5 and 6, the relative hardness increased by more than 50% in the first hours of curing. To use an AC 2514 resin with AC 2508 resin of high MFFT has not changed the hardness of the coating. The best of the relative hardness values obtained for the sample No. 4, which was the acrylic resin with the addition of AC 2514 as a primary base and 12% by weight kaolin as an inorganic thickener. The Figures 3-5 shows the change of relative hardness from time.

Conclusion

The test results show that the type of thickener has a significant influence for coating properties. Scratch resistance coatings and liquids, depends on the filler and type of modifier in composition. Application the wax with silica as a matting substance in water dispersion gives a better resistance to liquids than to use a silica.

The relative hardness test shows that the value hardness of coats increases with time of exposure from its application. Change of hardness in time confirms the cross linking properties of resins, also provides the creation of internal structures during the coating process. The inorganic thickener caused the better liquid resistance and scratch resistance.

The test results showed that the addition of an inorganic thickener improving the physical and mechanical properties of coatings.

Translation into English by the Author

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Events IYC'2011

September 2011

Challenges in Organic Materials & Supramolecular Chemistry International Symposia on Advancing the Chemical Sciences - Sep 02 - Sep 05, 2011 - Peking University, Beijing, China

Contemporary Chemistry for Sustainability and Economic Sufficiency 14th Asian Chemical Congress 2011 - Sep 05 - Sep 08, 2011 - Bangkok, Thailand

Artificial Photosynthesis: Faraday Discussion 155 - Sep 05 - Sep 07, 2011 - University of Edinburgh, UK

Reflections on the Surface of Reality Nottingham Chemistry Public Lecture Series - Sep 08, 2011 - Lecture Theatre X1, School of Chemistry, University of Nottingham, University Park, Nottingham, UK.

EUROanalysis 16 - Challenges in Modern Analytical Chemistry - Sep 11 - Sep 15, 2011 - Congress center SAVA, Belgrade, Serbia

The Butlerov's International Congress on Organic Chemistry - Sep 18 - Sep 23, 2011 - Kazan, Tatarstan, Russia 420088

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