WEATHERING OF POLYMER COATINGS, FORMED ON THERMALLY MODIFIED WOOD

Panayot A. Panayotov – Jivko V. Georgiev

Abstract

The weathering of polymer coatings, formed on thermally modified spruce wood was investigated. It was applied two regular coating systems (alkyd system; waterborne acrylate system). It was make some marks on destructions in wood and coating during two year outdoor exploitation. It is discover that after two years exploitation waterborne acrylate protection have a local destruction in crater form, while alkyd system is practically destructed in zone near to end. Thermally modified wood without coating become grayish and cracked in the ends. This tendency is also valid for alkyd protection, but not really valid for waterborne acrylate. The coatings do it with alkyd system protection has character destruction in zone of summer timber, which is more underlined for tangential samples. In pole of our experience we offer some differences in operation and materials for protection when you use thermally modified spruce.

Key words: *thermally modified spruce wood; weathering; alkyd coatings; acrylic coatings*

INTRODUCTION

Thermal treatment is good alternative to chemical modification for wood [1].This treatment changes the structure of cell walls in wood; the result of this is lower absorption ability, lower density and better resistance on fungi attacks. It is useful on conifer species (softwood) and on hardwood species as well. The results of thermal treatment (190-220°C) are destruction of hemicelluloses and separation of some extractives from wood. The thermally modified wood has a soft brown colour, depend of the temperature of receiving with well-defined texture. Thermally modified wood has two standards about treatment classes: Thermo-S and Thermo-D. Thermo-S is wood received after heated to 190ºC. Thermo-D is wood received after heated to 212ºC. The average tangential swelling and shrinkage due to moisture for Thermo-S class treated wood is 6-8%. The average tangential swelling and shrinkage due to moisture for Thermo-D class treated wood is 5-6% [4]. The decreased equilibrium moisture content of the wood improves its stability, which in turn reduces the cracking of the wood. These advantages make thermally modified wood preferable for use in decking, balconies and cottages. Due to its highly hygienic nature, colour, and decreased thermal conductivity, thermally modified wood is well suited for sauna benches and skirting boards. This wood has a good sticking ability and easy lacquer application. For better surface resistance the thermally modified wood needs to be coated with lacquers and paints [3]. It hasn't enough information about exploitation of coated thermally modified wood in different conditions [2]. The main aim of this investigation is to discover and notice the changes in thermally modified wood spruce samples coated with different coatings during period of two years.

MATERIALS AND METHODS

For thermal treatment uses spruce wood samples with measurements 18/100/300 mm (last one on length of the fibers) with normal structure without knots. The samples are 12 with radial structure (HTSr) and 12 with tangential structure (HTSt). The samples are exposed in room conditions (air humidity 50-60% and temperature 20-23°C) for 7d. The treatment is provided in vacuum thermo chamber with air surrounding. The samples are heated by stages: 1.heating to 70°C for 1h; 2.heating to 105°C for 1h; 3.heating to 135°C, supplying the temperature for 7h, cooling to room temperature and staying in this condition for 24h; 4.heating to 135°C for 3h and supplying the temperature for 3h; 5.heating to 190°C for 1h, supplying the temperature for 2h, cooling to room temperature and staying in this condition for 48h; 6.heating to 190°C for 5h, supplying the temperature for 4h, cooling to room temperature and staying in this condition for 72 h; 7.conditioning the thermally modified wood in room temperature and humidity for 7 d.

On the treated samples are formed three layers of alkyd based coating Valtti color satin TVT3056 produced by TIKKURILA-Finland and waterborne coating produced by RENNER-Italy, which contain of one coat preservative stain YM M040/T30 and two layers clear waterborne acrylate topcoat YO 30M317/-. The coatings formed with alkyd self-sealer have a middle dry mass 90 g/m² and middle dry thickness 87μm. The coatings formed with waterborne acrylate topcoat have middle dry mass 92 g/m² and middle dry thickness 92μm. The samples are exposed outdoor on standing sloped on 45° angle (Figure 1) with south exposure in the yard of University of Forestry- Sofia. This exposure continues two year, during this period the samples are measured and are noticed visible changes in wood and in coating (crackles; gloss changes; colour changes; bubble evidence; undertaken coatings).

The destructions are marked by point from 1 to 5: mark 5 is for condition without any defects; mark 4 is for 2-3 small local defects on surfaces and gloss retentions; mark 3 is for more of 5 small local defects and colour changes; mark 2 is for big defects and small local undertaken coatings; mark 1 is for practically destructed coatings and surfaces.

RESULTS AND DISCUSSION

All results for thermal treatment of spruce wood are in table 1. From this table is visible that spruce wood loses 2.55-8.45% mass in this treatment. The result of treatment is that the colour of samples becomes brown with well-defined fibres (Figure 1). After conditioning for 7d, the samples have with 3.58-4.73% humidity.

On the standing has three different series with samples. The first one included 6 radial and 6 tangential thermally treated spruce samples, which are coated with waterborne coating (HTSR). During two years exposure the samples are measured and are noticed visible differences in coating and in wood. The first visible changes come in the end of the first year and they are result of hailstorm (Figure 2). The coatings have small craters on the surfaces, which accelerate the destructions in the next months. These local defects grow in the end of the second year, especially on one sample (Figure 2). The coating loses adhesion to wood in these spots and whole zones of it are undertaken. The ends are not cracked, but in tangential samples have small curving in the ends.

Tabl.1 Mass changes spruce samples after heat treatment

Index	Start mass g	Absolutely dry mass g	Final mass g	Mass losses		Mass after condition g	Moisture %
				ΔM, g	ΔM,%		
HTSr -1	208,73	196.92	191,9	5,02	2,55	199,99	4.22
HTSr- 2	213,75	201.65	197,09	4,56	2,26	205,53	4.28
HTSr -3	176,26	166.28	164,01	4,27	2,57	171,36	4.48
HTSr- 4	177,88	167.81	163,16	4,65	2,77	170,47	4.48
HTSr -5	222,05	209.48	203,85	5,63	2,69	212,76	4.37
HTSr- 6	174,22	164.36	159,92	4,44	2,70	167,24	4.58
HTSr -7	175,10	165.19	159,79	5,40	3,27	167,35	4.73
HTSr- 8	173,74	163.91	158,17	5,74	3,50	165,40	4.57
HTSr -9	176,85	166.84	160,73	6,11	3,66	168,10	4.58
HTSr -10	178,83	168.71	162,15	6,56	3,88	169,61	4.61
HTSr- 11	212,96	200.91	192,82	8,04	4,02	200,44	3.95
HTSr -12	212,23	200.88	192,54	8,54	4,15	200,18	3.97
HTSt-1	228,20	215.28	207,09	8,19	3,80	216,39	4.49
HTSt-2	208,39	196.59	188,16	8,43	4,29	196,73	4.55
HTSt-3	224,43	211.73	203,12	8,61	4,07	210,83	3.79
HTSt-4	242,84	229.09	220,07	9,02	3,94	228,11	3.65
HTSr-5	197,23	186.07	177,37	8,52	4,71	184,82	4.21
HTSr-6	233,53	220.31	210,16	10,15	4,61	217,68	3.58
HTSt-7	197,48	186.30	176,98	9,32	5.00	183,87	3.89
HTSt-8	199,01	187.74	177,55	10,19	5,43	184,45	3.89
HTSt-9	203,18	191.68	182,05	10,63	5,54	187,95	3.24
HTSt-10	179,70	169.53	159,62	9,91	5,84	165,71	3.82
HTSt-11	237,98	224.51	209,41	15,10	6,72	216,49	3.38
HTSt-12	196,05	184.95	169,32	15,63	8,45	176,11	4.01

The second group consists of 3 radial and 3 tangential thermally treated spruce samples, which are coated with alkyd based semi transparent colour self-sealer (HTST).

During two years exposure the samples are measured and are noticed visible differences in coating and in wood (Figure 3). The samples haven’t any visible defects after hailstorm in the end of the first year.

Figure 1 Spruce samples; at left thermally modified wood; at right natural spruce

Figure 2 Destruction of coating and wood on sample HTSrR-2 after 2 years

Figure 3 Destruction of coating and wood on sample HTStT-9 after 2 years

The alkyd coating has perfect elasticity because it is modified with line oil. In the end of the second year the colour of coating is changed, there are big crackles in the ends and the coatings are torn on the border between spring and summer wood. The ends of the tangential samples are curved more than the waterborne painted ones. The coatings are particularly destructed. The third group consists of 3 radial and 3 tangential thermally treated spruce samples without any coatings (HTSU). The samples are measured and noticed the visible differences in wood during two years outdoor exposure. Uncoated thermally modified wood has good structure stability during all exposure. The colours of the samples are extremely greyish in the ninth week.

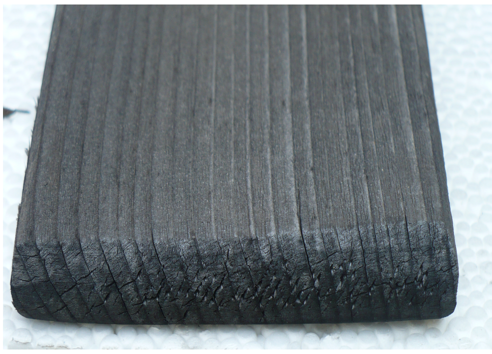

Figure 4 Destruction of wood on sample HTSrU-10 after 2 years

Tabl. 2 Changes in thermally modified spruce wood outdoor exposed for two years

Index	Starting date 10.06.2006		10.06.2007 Weather: sunny		10.06.2008 Weather: sunny	
	M_s, g	mark	M_{1y}, g	mark	M_{2y}, g	mark
HTSrR-1	199.02	5	202.03	4	217.25	3
HTSrR-2	205,53	5	215,12	2	220,96	1
HTSrR-3	171,36	5	175,25	3	187,08	3
HTSrR-4	170,47	5	173,38	3	184,40	2
HTSrR-5	212,76	5	221,21	4	229,12	3
HTSrR-6	167,24	5	186,54	3	189,21	2
HTStR-1	216,39	5	222,23	3	228,84	2
HTStR-2	196,73	5	205,64	3	210,21	2
HTStR-3	210,83	5	218,54	3	228,05	2
HTStR-4	228,11	5	233,77	3	246,66	2
HTStR-5	184,82	5	189,56	3	198,71	2
HTStR-6	217,68	5	222,23	3	237,43	2
HTSrT-7	175,87	5	175,23	4	176,58	2
HTSrT-8	174,37	5	175,02	4	175,05	2
HTSrT-9	177,19	5	178,01	4	178,43	1
HTStT-7	193,4	5	193,92	4	194,88	1
HTStT-8	193,36	5	192,7	4	192,74	1
HTStT-9	197,41	5	197,28	4	197,09	1
HTSrU-10	169,61	5	173,29	3	173.40	1
HTSrU-11	200,44	5	205,99	3	206.27	1
HTSrU-12	200,18	5	204,86	3	204.84	1
HTStU-10	165,71	5	168,54	2	168.38	1
HTStU-11	216,49	5	223,88	2	223.76	1
HTStU-12	176,11	5	177,69	2	177.76	1

Crackles in the ends appear in sixth month and become well defined in the end of the second year (Figure 4). The wood is with underlined fibres after one and half year. The ends of tangential samples are curving like alkyd painted ones. All of destruction processes are more intensive in tangential samples.

CONCLUSION

The results of the investigation are that waterborne coatings haven’t good adhesion to wood in outdoor exposure during long periods of time. It is also valid for alkyd based coatings. Alkyd based coating have a better adhesion to thermally modified wood than acrylate ones, but they have worse stability in outdoor exposure. The acrylate coatings need preservative stain for better absorption in spruce wood, which to provide better adhesion to acrylate topcoat. All the results show that waterborne acrylate coatings are better than alkyd coating for thermally modified wood. In our case the destruction in alkyd coated samples start later than acrylate, but they are more intensive and lead to particularly destruction of the coating. Uncoated thermally modified wood has good dimension stability in outdoor exposure but they need coating for better results.

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