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The Effect of NanoParticles and Common Furniture Paints on Water Resistance Behavior of Poplar Wood (*P.nigra*)

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Abstract

In this study, the effect of nano zycosil, nano zycofil, acid catalyzed lacquers, nitrocellulose lacquers and common Polyester used in furniture industry, in improve of wood water resistance was investigated. For this aim, poplar (*P.nigra*) lumbers provided from the sapwood area dried according to T_6E_3 schedule. Then, samples with dimension of 20×20 mm were prepared. They were coated and immersed with the nano particle and paints. A series of samples were dried in laboratory environment and others in an oven with temperature of 103±2. After drying process, the water absorption of treated samples was measured 2, 24, 72, 168 h following the immersion. The results revealed that the pattern of water absorption for the paints and nano particles is different. The samples coated with acid catalyzed lacquers and nitrocellulose lacquers and dried in laboratory environment as well as those coated with 100% Nano zycosil and dried in the oven had the highest resistance to water absorption. The treated samples dried in the oven had a greater water resistance than those dried in the laboratory.

Key words: Paint, Wood, Water absorption, Nanoparticles

Introduction

There have been many attempts to decreasing the water absorption of wood (Sturm 1994, Mansouryar 2008). Mansouryar (2008) had stated that by using of paraffin emulsion, quaternary ammonium and hydrated starch water resistance of poplar wood can be improved. If water resistance of wood could be decreased by water resistant coating application of wood will be expanded .Nanoparticles and coatings are among materials that can be used for decreasing of wood water absorption since they had much more surface area that can result in improvement of its physical and mechanical properties (Celiker 2005). Nanocoatings have some desired characteristics such as anti weathering, anti wearing and water proof properties (Mahmodi 2007, Kaygin and Akgun 2008, Kaygin and Akgun 2009). Coating of wood surface with nano zirconium modified polyolefin compounds results in improvement of its water resistance due to increase of water contact angle (Write & Gordon 2006). In this study by employment of zycosil and zycofil nano particles in mixture with different coating paints, potential of nano technology in improvement of water resistance of poplar wood was investigated.

Material and Methods

Sampling

Poplar lumbers of 1500×200×50 mm were dried according to the drying program (code of T_6E_3, table 1) and they were converted to boards of 500×200×20 mm and finally samples with dimension of 20×20×20 mm were cut from sapwood areas of the boards.

Table 1: drying program (code of T_6E_3) was used for drying of poplar plank

Initial Moisture (٪)	Dry bulb temperate (^{0}C)	Wet bulb temperate (^{0}C)	Different wet and dry temperate (^{0}C)	Relative Humidity (٪)	Equilibrium Humidity (٪)
...›60	49	46	3	84	
60	49	45	4	80	16
50	49	43	6	69	12.9
40	49	39	10	53	9.8
35	49	30	19	22	5.1
30	54	26	28	10	1.4
25	60	32	28	14	2.5
20	65	37	28	18	1.6
15	82	54	28	25	6.3
10	82	54	28	25	6.3
8	82	54	28	25	6.3
conditioning	82	64	18	50	9
Equalizing	82	74	8	80	14.1

Acid catalyzed lacquers, nitrocellulose lacquers and Polyester of this study were based on alkyd resin that was provided from paint and resin Corporation of dorsa chemistry (brelian). nano zycsil and nano zycofil were purchased from zydex company.

Coating of Samples

Two kinds of treatments with nanoparticle and paints were used. Some of the samples were coated by hair brush and some by dipping in nanoparticles for 1 hour. For coating with Acid catalyzed lacquers and nitrocellulose lacquers, first surfaces of wood was cleaned then Acid catalyzed lacquers and nitrocellulose lacquers with specified amount of instant thinner of 10000 were diluted and with use of a brush painting were applied. Drying of paint in the environment condition lasted between 15 to 20 min. besides, Polyester after preparation of surfaces was mixed with 10 percent catalyst (hardener, absorber) and after dilution with instant thinner of 10000, by using of hair brush surfaces of wood coated and drying time in environment lasted for 15 to 20 min. For coating with nano zycsil ,first nanoparticles with different ratio was added to water and by using of hairbrush surface of wood was coat and dried in laboratory condition (23±2°C) for 24h. For coating of wood surface with nano zycofil it was added by ratio of 1:1 to water and was coated by hair brush (Table2). First group of coated samples were dried in laboratory condition for 24h and second group were dried in oven (103±2°C) for 24h.

Table2: description of treatments

Treatment code	Treatment
Sample	Without coating
CZF	Coated by 50 % nano-zycofil and climatically dried
100٪CZF	Coated by 100 % nano-zycofil and oven dried
CZ	Coated by nano-zycosil and climatically dried
10٪ CZ	Coated by 10 % nano-zycosil and oven dried
50٪ CZ	Coated by 50 % nano-zycosil and oven dried
100٪ CZ	Coated by 100 % nano-zycosil and oven dried
FZ	Coated by 50 % nano-zycosil and climatically dried
100٪ FZ	Coated by 100 % nano-zycosil and climatically dried
FZF	Coated by nano-zycofil and climatically dried
CZ.ZF	Coated by nano-zycofil and zycofil, climatically dried
CPZZF	Coated by polyester, nano-zycofil , zycofil and climatically dried
CSCZZF	Coated by sealer and nitrocellulose lacquer, nano-zycofil , zycofil and climatically dried
CPS	Coated by polyester
CSC	Coated by sealer and nitrocellulose lacquer and polyester lacquer

After drying, water absorption of the samples was measure by dipping of them in still water for 2, 24, 72 and 168h (table 3).

Result and discussion

As one can see in the table 3,most improvement in water absorption was related to the treatments of csc, cpzzf, csczzf, fz, czf, fzf, sample, cz.zf, cps and cz respectively and there was a meaningful difference in significance level of 1% between treatments of csc and cpzzf (2.86 and1.46) with reference one (table 5, 6).water absorption of the coated samples was more than dipped one .The results showed that efficiency of using nanoparticles of zycosil and zycofil in improving of water absorption of wood depend on method of applying and kind of drying of this particles.

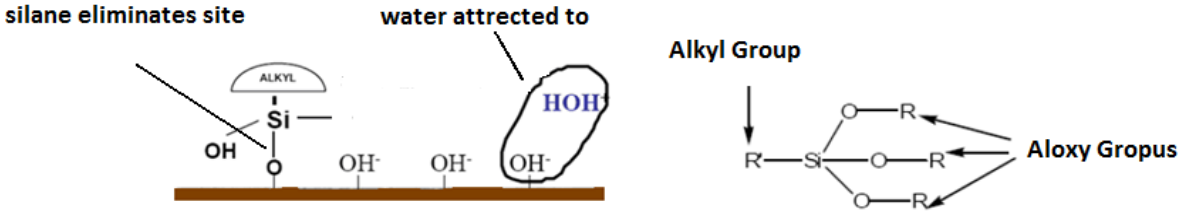

Figure 1: mechanism of silane.

Formulation and suggested mechanism of reaction of nano zycosil and hydroxyl groups of wood surface.

Table 3: Average water absorption of coated and dried samples after different time in laboratory condition.

Treatment	Treatment code	coating wight (g/m2)	absorbtion after 2h	absorbtion after 24h	absorbtion h after72	absorbtion after 168h
1	CSC	108/25	23/27	46/33	78/28	85/30
2	CPZZF	125/25	39/15	69/98	97/52	105/55
3	CSCZZF	156/15	40/121	75/93	101/44	107/41
4	FZ	302/22	41/06	79/53	111/91	122/72
5	CZF	37/19	42/63	73/34	104/07	111/28
6	FZF	298/99	42/69	83/20	109/84	117/23
7	Sample	----------	43/49	96/13	108/71	118/73
8	CZ.ZF	61/38	51/13	101/11	129/67	132/50
9	CPS	51/75	73/37	99/66	121/62	125/22
10	CZ	41/33	75/94	113/47	133/35	139/11

Table 4: Average water absorption of coated and dried samples after different time in oven.

Treatment	Treatment code	coating wight (g/m2)	absorbtion after 2h	absorbtion after 24h	absorbtion h after72	absorbtion after 168h
1	100٪FZ	341/66	16/7	41/18	56/86	65/98
2	10٪CZ	48/61	22/68	61/21	92/12	114/53
3	100٪CZ	72/22	26/43	78/6	100/95	117/87
4	50٪CZ	38/88	27/89	75/46	103/76	118/69
5	100٪CZF	54/16	29/08	77/48	100/12	115/53
6	reference	---------	43/49	96/13	108/71	118/73

Table5: Significance test of coated and dried samples after different time in laboratory condition.

Treatment	Treatment code	soak time (h)	average	SD	F
1	CSC	2	18/88	2/31	1/448**
2	CSC	24	41/65	3/13	2/911**
3	CSC	72	74/75	3/06	1/27**
4	CSC	168	81/91	4/02	1/64**
5	CPZZF	24	69/98	3/31	2/3**
6	CPZZF	72	97/52	2/44	2/61**
7	CPZZF	168	105/55	2/54	6/26**

Table6: Significance test of coated and dried samples after different time in oven.

Treatment	Treatment code	soak time (h)	average	SD	F
1	100٪FZ	2	16/07	0/87	2/86**
2	100٪FZ	24	41/18	1/79	5/54**
3	100٪FZ	72	56/85	3/82	0/55**
4	100٪FZ	168	65/98	3/88	1/78**

5	10٪CZ	2	22/68	1/45	2/17**
6	10٪CZ	24	61/21	5/69	0/48**
7	10٪CZ	72	92/12	5/24	0/65*
8	100٪CZ	2	26/43	5/2	0/00001*
9	50٪CZ	2	27/89	4/17	0/21*
10	50٪CZ	24	75/46	10/77	0/44*
11	100٪CZF	2	29/08	4/23	0/11*
12	100٪CZF	24	77/48	9/73	1/37*

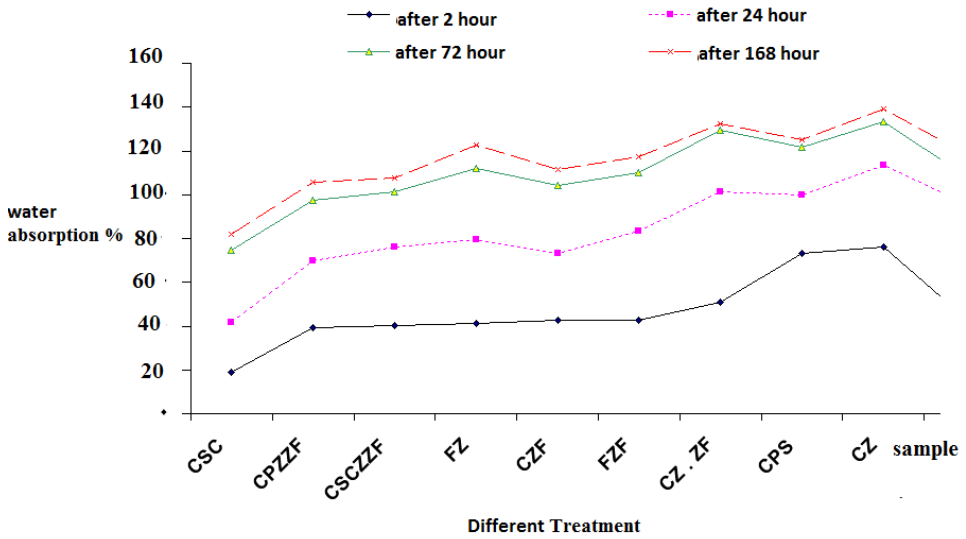

Figure2: Average water absorption of coated and dried samples after different time in laboratory condition.

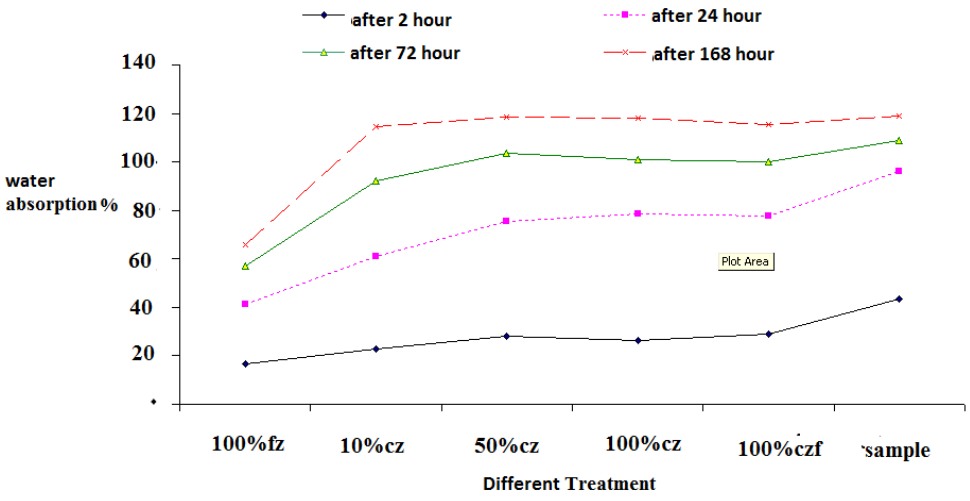

Figure3: Average water absorption of coated and dried samples after different time in oven.

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