

Comparative studies of varying characteristics of wood surfaces after exposure to natural climate and accelerated aging

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Abstract: *Comparative studies of varying characteristics of wood surfaces after exposure to natural climate and accelerated aging.* Tests were conducted on predetermined elements of coated pinewood samples before and after accelerated aging and after 18, 54, 78, 114 and 136 months of exposure to natural climate. The samples were tested for changes in colour, development of blistering, flaking and changes in gloss. The results have shown that only differences in the yellowish and gloss were noticed. The gain in yellowish tinge was three times greater, after 18 months, than in those samples which underwent accelerated aging and 8 times greater after 136 months. The prolonged exposure to natural climate made the effect of the impregnation of the samples clear to see. It was seen that the gloss of the finish was lower after 18 months than originally, but then after 54 months the finish regained some of its glossiness which then again fell after 78. After 114 and 136 months degree of glossiness was stabilized. It was also observed that using an impregnate on the wood before finishing it had no clear effect on the change in gloss after either trial period.

Key words: windows finishing, ageing of paint, colour changes, blistering, flaking, cracking, gloss

OBJECTIVES

The purpose of this research is to analyze the influence of accelerated weathering (changes in temperature and relative air humidity) and the influence of long term weathering (18, 54, 78, 114 and 136 months) on paint coats. Paint coatings were tested for change in colour, blistering, flaking, cracking and gloss. An evaluation of the influence of pre-painting impregnation, or lack thereof, was also conducted.

METHODOLOGY

The methods for testing the necessary qualities, was outlined in a previous publication (Kedzierski, 2008). This research was conducted in accordance with PN-EN 927-3:2002. Paints and varnishes – coating materials and coating systems for exterior wood – Part 3: Natural weathering tests.

Accelerated aging (weathering) of paint coats was conducted according to standard ASTM D 3459-98 “Standard Test Method for Humid-Dry Cycling for Coatings on Wood and Wood Products”. Note however, that the time of the second stage was changed from 48 to 62 hours.

After the samples underwent accelerated aging in weather chamber they were tested for: blistering, flaking, cracking, gloss (PN-EN ISO 2813:2001) and yellowing. Tests were performed in accordance with PN-EN 927-3:2002. The standard PN-EN 927-3:2002 requires implementation of ISO/DIS 7724-1:1997 to ISO/DIS 7724-3:1997 in order to establish colour and colour changes of tested products. Above standards were not in existence at time of testing so samples were tested for yellowing of coatings in accordance to standard PN 72/C-81546. Yellowish tinge of paint coat was measured in the beginning (W_{z1}) before accelerated aging and after (W_{z2}), and on samples not exposed to accelerated aging, before and after the tests.

$$\Delta W_z = (W_{z2} - W_{z1}) [\%]$$

The same tests of paint coats were carried out on the other group of wood samples before and after 18, 54, 78, 114 and 136 months of exposure to normal weathering.

ANALYSIS

The following is a series of tables which depict the information gathered throughout the experimentation process. Table 1 depicts the characteristics of the paint coats before aging and Table 2 depicts those characteristics after aging. Table 3 however, shows the characteristics of the paint coats after 18, 54, 78, 114 and 136 months of exposure to natural climate.

Table 1: Characteristics of Coats before accelerated aging

Tested Characteristic	Variant						Applied Standard
	A		B		C		
	Samples to be aged	Comparative Samples	Samples to be aged	Comparative Samples	Samples to be aged	Comparative Samples	
Gloss	23,73	25,41	22,60	23,89	23,83	24,77	PN-EN ISO 2813:2001
Yellowish Tinge W_{z1} [%]	4,89	5,12	4,51	4,58	4,99	4,92	PN-72/C-81546

Table 2: Characteristics of Coats after accelerated aging

Tested Characteristic	Variant						Applied Standard
	A		B		C		
	Aged Samples	Comparative Samples	Aged Samples	Comparative Samples	Aged Samples	Comparative Samples	
Gloss	20,31	23,21	20,85	22,43	21,98	23,05	PN-EN ISO 2813:2001
Loss of Gloss	3,42	2,20	1,75	1,46	1,85	1,72	PN-EN 927-3:2002
Yellowish Tinge W_{z2} [%]	5,73	5,25	5,37	4,81	5,84	5,16	PN-72/C-81546
Increase in Yellowish Tinge ΔW_z [%]	0,84	0,13	0,86	0,23	0,85	0,24	PN-72/C-81546

Table 3: Characteristics of coats exposed to 18, 54, 78, 114 and 136 months of natural climate

	Variant	Measured Gloss according to PN-EN ISO 2813:2001	Decrease in Gloss according to PN-EN 927-3: 2002	Yellowish Tinge W_z [%]	Increase in Yellowish Tinge ΔW_z [%]
				According to PN-72/C-81546	
Characteristics before any exposure to natural climate	A	24,59	-	4,85	-
	B	23,68	-	4,69	-
	C	24,31	-	4,77	-
Characteristics after 18 months exposure to natural climate	A	22,29	2,30	7,41	2,56
	B	21,80	1,88	7,11	2,42
	C	22,35	1,96	7,12	2,35
Characteristics after 54 months exposure to natural climate	A	23,16	1,43	9,35	4,50
	B	22,11	1,57	8,89	4,20
	C	22,87	1,44	8,54	3,77
Characteristics after 78 months exposure to natural climate	A	23,02	1,57	9,88	5,03
	B	21,92	1,76	9,44	4,75
	C	22,62	1,69	9,14	4,37
Characteristics after 114 months exposure to natural climate	A	23,11	1,48	10,94	6,10
	B	21,81	1,87	10,12	5,43
	C	22,61	1,70	10,12	5,35
Characteristics after 136 months exposure to natural climate	A	23,13	1,46	11,54	6,69
	B	21,86	1,79	10,95	6,26
	C	22,61	1,70	10,49	5,72

After analyzing the results one can conclude that the coatings of wood samples at the beginning of the tests and after accelerated aging, as well as the ones exposed to 18, 54, 78, 114 and 136 months of normal weathering, did not show any signs of flaking, mold grow or cracking. Blistering was 3 (S2) and did not change. Only gloss and yellowish tinge were affected.

Accelerated aging affected the change in increase of yellowish tinge ΔW_z . Increase in yellowish tinge was measured to be 0.84% to 0.86% and was similar for all the variants of finishes. Increase in yellowish tinge in not aged coats was measured to be 0.13% to 0.24%, and as is clear, it shows greater deviation. Paint coats exposed to accelerated aging are showing three to six times higher increase in yellowish tinge as the ones which were not aged. The increase in yellowish tinge was similar for all the samples used in all variants of finishes under 18, 54, 78, 114 and 136 months of exposure to natural weathering tests have got higher influence than accelerated aging. Increase in yellowish tinge after 18 months of exposure was measured to be 2.35% to 2.56% and was about 3 times higher than in accelerated aging samples. After 54 months of exposure to normal climate, the yellowing was 3.77% to 4.50%, about 5 times that of the samples that underwent the accelerated aging process, and about twice that of the yellowing at 18 months. After 78 months, the gain in yellowish tinge was 6 times that after weathering, between 4.37% to 5.03%. After 114 months, the gain in yellowish tinge was 7 times that after six months, between 5.35% to 6.10%. Naturally, after 136 months, the gain in yellowish tinge was accelerating and was almost 8 times that after weathering, between 5.72% to 6.69%. Already, after 18 months it was possible to see the result of the impregnates on the yellowing: those sample which were not impregnated yellowed the least, those impregnated for 10 minutes were about 3% higher in their change in yellowing, and

those impregnated for 2 minutes showed a 9% higher gain in yellowing. The results after 54, 78, 114 and 136 months showed the same trend. After 136 months, those samples that were not impregnated showed the least yellowing, those that underwent 10 minutes of impregnating were 9% higher in yellowing, and those that underwent 2 minutes of impregnating were 17% higher in yellowing.

Weathering and the 18 months of exposure to natural climate, it was possible to see that the gloss of the finish decreased by 7.7% to 14.4%. While, after 54 months, it was possible to see that the finishes regained 1.4% to 3.9% of their gloss, with respect to the gloss after 18 months. This could be due to the progressive hardening of the coat of paint throughout the time between 18 and 54 months of exposure. However, after 78 months the gloss fell back down to between 6.4% and 7.4%. After 114 and 136 months the gloss shown stabilized values. The results showed no trends dependant on impregnation of the wood before painting.

CONCLUSIONS

- 1) Accelerated aging and 18, 54, 78, 114 and 136 months of exposure to natural climate causes increased yellowish tinge to paint coats. The gain in yellowish tinge after 18 months was three times that of accelerated aging, and the gain after 136 months was almost 8 times that of accelerated aging.
- 2) The degree of yellowing was affected by the impregnation in natural climate. After 136 months, those samples that were not impregnated showed the least yellowing, those that underwent 10 minutes of impregnating were 9% higher in yellowing, and those that underwent 2 minutes of impregnating were 17% higher in yellowing.
- 3) Accelerated aging and 18 months of exposure to natural climate caused a 7.7% to 14.4% loss in the gloss of the paint coat.
- 4) After 54 months the samples regained about 1.4% to 3.9% gloss with respect to their level of gloss after 18 months of exposure to normal climate.

REFERENCES:

KĘDZIERSKI A., 2008: A study of the change in characteristics of wood finishes due to accelerated aging and exposure to natural climate. *Annals of Warsaw University of Life Sciences – SGGW. Forestry and Wood Technology* No 63, 2008

Streszczenie: *Badania zmian właściwości powłok malarskich pod wpływem przyspieszonego starzenia i długotrwałego działania normalnego klimatu.* Zbadano podstawowe właściwości powłok malarskich na drewnie sosnowym przed i po przyspieszonym postarzeniu a także po 18, 54, 78, 114 i 136 miesięcznym oddziaływaniu normalnego klimatu. Określone właściwości powłok to: zmiana barwy, spęcherzenie, złuszczenie i połysk. W wyniku badań stwierdzono, że sztuczne starzenie jak i też 18, 54 i 78, 114 i 136 miesięczne oddziaływaniu normalnego klimatu powoduje wzrost zażółcenia powłok. Przyrost stopnia zażółcenia powłok po 18 miesiącach oddziaływania normalnego klimatu na powłoki był około trzykrotnie, a po 136 miesiącach blisko ośmiokrotnie większy niż wywołany sztucznym starzeniem. Zaznaczył się wpływ impregnowania drewna na przyrost stopnia zażółcenia powłok wywołany oddziaływaniem normalnego klimatu. Sztuczne starzenie oraz 18 miesięczne oddziaływanie normalnego klimatu spowodowało spadek połysku powłok natomiast po 54 miesiącach zanotowano nieznaczny wzrost połysku powłok w stosunku do wartości jakie wykazywały po 18 miesiącach. Jednakże po 78 miesiącach nastąpił spadek połysku, która to wartość utrzymywała się w kolejnych miesiącach badań. Nie stwierdzono wpływu impregnowania drewna przed malowaniem na utratę połysku powłok.

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