FOLIA FORESTALIA POLONICA
Seria B, zeszyt 26, 1995

THE PENETRATION OF PRESERVATIVES INTO POPLARWOOD

by Tadeusz Wytwer

Warsaw Agriculture University. Department of Wood Protection

The permeability of poplarwood on the saturated waterborne preservatives and coal tar creosote was investigated. The influence of moisture of sapwood and heartwood and time of immersion on the penetration and the retention preservatives was determined.

INTRODUCTION

Until now poplarwood has been used building material only in a limited extent. Density of poplarwood is about 450 kg/m^3, its physico-mechanical properties are close to those of sprucewood. The presence of differently coloured zones-heartwood and sapwood is characteristic feature of poplar timber. Despite of this poplarwood is easy decayed by fungi and may be demaged by wood-destroying beetles. Natural resistance to the biological attack is very low. It can be said, that this wood is perishable. The durability of poplarwood can be changed by impregnation with preservatives against biological attack and as well as from fire. Research works were carried on the penetration of preservatives into softwood, especially into pinewood. They were focusing on the penetration of preservatives into pine sap-and heartwood (1, 5,10,11), sprucewood (6, 12), on influence of the structure of wood on the penetration (3, 4, 7, 8), on waterborne preservatives penetration mechanism and its distribution inside wood (2, 6, 13). Penetration of preservatives into softwood was subject of many other research works. A little research has been done in the poplar area, in the past. Van Acker, Stevens and Haas determined the influence of colonel variability on the impregnability of poplar hybrids (9).

The aim of this work was to investigate permeability of poplarwood with preservatives by non pressure methods and the influence of moisture of wood, time of immersion, type of preservatives on the results of impregnation.

METHODS AND MATERIALS

Wood. Poplarwood (Populus nigra L.) has been used as test samples with proportion 40x40x50 mm and moisture 12, 28 (fibre saturation point), 50%. The cross-sections of samples were brushed with paraffin before treatment. The were made separately from sap-and heartwood. Density of wood, moisture 15%, was 430 kg/m^3.

Preservatives. The following five waterborne preservatives were used (10% concentration): Biotox R-12, CF preservative (16), F-8 preservative (15), SF preservative (14), BS preservative (17) and one oil preservative - coal tar creosote.

Impregnation. The impregnation of the samples has been carried out in laboratory conditions by immersion method during 15, 30 and 50 minutes. The absorption of the solution was determined by weighing samples before and after treatment. The experiment was five times repeated in identical conditions. After treatment the samples were seasoned: samples of 12% water content in laboratory conditions-during 14 days, samples of 28 and 50% water content in damp chamber (ca 97%) during 7 days, next in laboratory conditions 7 days too. At the end of the seasoning period the samples were cut across the wood fibre in two places -15 and 30 mm from cross section. The depth of penetration was determined on two cross section; on one side of the sample 3 measurements were taken with 10 mm distance between them, on one cross section 12 measurements, in one sample -24 measurements. The presence of Biotox R-12 and of BS preservative inside wood has been revealed by cucrcumin indicator, the presence of CF, F-8 and SF preservatives by zirconium-alizarin indicator.

Results of the depth of penetration (mm) and quantity of preservatives (g salt/m^2, g oil/m^2) are showed in table 1 and table 2.

RESULTS

Depth of penetration (tab. 1 and 2) Sapwood. Investigated preservatives have penetrated into poplar sapwood on the depth: Biotox R-12 from 2,0 to 9,3, preservatives CF 1,5 to 4,9, F-8 1,6 to 4,5, SF 1,7 to 3,6, BS 2,9 to 10,5 and oil preservative 0,2 to 5,6 mm. Waterborne preservatives have penetrated shallowly into wood containing 12% of water, deeper into wood containing 28% of water and the deepest into wood containing 50% of water, coal tar - in the opposite way. The immersion of time from 15 to 60 minutes hasn't influenced the depth on penetration of preservatives into wood of 12% moisture but they

Table 1
Tabela 1

The results of impregnation of poplar-sapwood with preservatives
Wyniki nasycenia środkami ochrony bielastego drewna topolowego

Preservatives Środki ochrony	Moisture content, % Wilgotność drewna, %	Time of immersion Czas kąpieli min.	Depth of penetration, mm Głębokość wnikania, mm			Retention, g/m2 Ilość soli, g/m2		
			minim. minim.	max. max.	mean śred.	minim. minim.	max. max.	mean śred.
1	2	3	4	5	6	7	8	9
Biotox R-12	12	15	0.9	3.8	2.0	8.8	16.3	12.3
		30	1.4	3.9	2.5	13.8	16.3	15.5
		60	1.6	5.3	2.9	11.3	17.5	14.3
	28	15	2.6	5.3	3.9	8.8	11.3	9.5
		30	3.2	5.3	3.9	13.8	16.3	15.0
		60	3.0	7.2	4.9	7.5	12.5	10.3
	50	15	3.8	9.5	7.3	6.3	10.0	7.8
		30	5.0	10.0	7.6	3.8	6.3	4.5
		60	7.2	12.0	9.3	8.8	13.8	10.4
Preparation CF Preparat CF	12	15	0.9	2.8	1.5	10.0	16.3	12.8
		30	0.8	4.6	1.6	12.5	20.0	16.3
		60	1.0	4.0	1.8	17.5	20.0	18.0
	28	15	1.4	4.2	2.4	11.3	15.0	12.5
		30	2.0	4.2	2.9	11.3	13.8	12.8
		60	1.4	4.6	3.0	12.5	20.0	16.5
	50	15	1.9	5.3	3.7	3.8	6.3	5.3
		30	2.1	6.4	4.4	5.0	10.0	7.5
		60	3.0	7.5	4.9	6.3	8.8	7.9
Preparation F-8 Preparat F-8	12	15	0.9	3.2	1.9	15.0	20.0	18.0
		30	0.9	3.4	1.6	15.0	23.8	18.5
		60	0.9	4.8	1.9	20.0	27.5	23.8
	28	15	1.0	4.8	3.3	8.8	15.0	12.0
		30	2.2	5.4	3.8	12.5	16.3	13.8
		60	2.5	6.2	4.4	13.8	18.8	16.8
	50	15	2.0	5.9	3.5	3.8	7.5	5.8
		30	2.7	8.0	4.0	7.5	11.3	8.8
		60	2.0	8.0	4.5	5.0	10.0	6.0
Preparation SF Preparat SF	12	15	0.3	6.2	1.7	11.3	17.5	13.8
		30	0.7	4.0	1.9	13.8	20.0	16.5
		60	0.8	8.0	2.0	13.8	17.5	17.5
	28	15	0.7	5.2	2.1	7.5	11.3	9.8
		30	0.8	4.8	2.1	10.0	12.5	11.5
		60	0.8	3.7	2.1	8.8	12.5	10.5
	50	15	0.9	5.4	2.7	3.8	6.3	5.0
		30	1.7	6.2	3.4	7.5	10.0	8.5
		60	1.9	8.0	3.6	3.8	7.5	5.3

1	2	3	4	5	6	7	8	9
Preparation BS Preparat BS	12	15	1.3	6.1	2.9	8.8	16.3	12.3
		30	1.3	8.0	3.2	13.8	23.8	17.3
		60	1.9	8.0	3.5	22.5	31.3	27.0
	28	15	3.1	6.2	4.6	10.0	13.8	11.0
		30	2.9	6.6	4.9	11.3	13.8	12.5
		60	3.3	7.2	5.2	13.0	21.3	17.9
	50	15	5.2	14.0	8.8	7.5	8.8	8.5
		30	7.5	14.5	9.8	10.0	15.0	12.5
		60	6.5	15.0	10.5	5.0	16.3	8.8
Coal tar creosote Olej impregnacyjny	12	15	0.8	7.9	4.9	112.5	175.0	140.0
		30	0.9	7.7	4.4	162.5	275.0	225.2
		60	2.5	8.0	5.6	137.5	200.0	177.5
	28	15	0.1	7.2	2.9	125.0	175.0	140.0
		30	0.4	7.2	3.0	112.5	187.5	145.0
		60	0.6	6.0	3.5	162.5	200.0	182.5
	50	15	0.0	1.1	0.2	50.0	87.5	67.5
		30	0.0	1.3	0.3	23.0	50.0	37.1
		60	0.1	1.3	0.4	62.5	62.5	62.5

have penetrated deeper into wood of 28 and 50% moisture, according to the increase of immersion time.

Heartwood. Waterborne preservatives have penetrated into heartwood : Biotox R-12 from 2,5 to 7,8, preservatives CF 2,0 to 5,7, F-8 2,4 to 6,7, SF 1,4 to 3,2, BS 3,4 to ca 20,0 and oil preservative 0,2 to 4,3 mm. Moisture of wood and time of immersion have influenced the depth of penetration of preservatives - similarly as in case of sapwood.

Quantity of preservatives (tab.1 and 2). Sapwood. The retention of preservatives by sapwood was absorbed: Biotox R-12 from 4,5 to 15,5, preservatives CF 5,3 to 18,0, F-8 6,0 to 23,8, SF 5,0 to 17,5, BS 8,5 to 27,0 and coal tar creosote 37,1 to 225,0 g/m^2. Wood has absorbed smaller quantity of preservatives with increase of its moisture, especially in interval between 28 and 50% moisture. The extension of immersion time has caused irregular increase retention of preservatives. The best results of impregnation was received for BS preservative.

Heartwood. Preservatives were absorbed by heartwood: Biotox R-12 from 4,8 to 20,3, preservatives CF 6,8 to 41,0, F-8 7,3 to 51,8, SF 7,3 to 24,0, BS 5,3 to 46,0 and oil preservative 50,0 to 297,0 g/m^2. Influence of moisture of wood and time of immersion on the retention of preservatives have been similar to sapwood. The permeability of poplar sap- and heartwood on the impregnation with preservatives was close to pine sapwood. Longer time of immersion caused, irregular, increase depth of penetration and retention preservatives. Bigger moisture of wood caused increase depth of penetration waterborne preservatives and reduce depth of penetration of oil preservative, especially in divide 28-50% moisture of wood.

Table 2
Tabela 2

The results of impregnation of poplar-heartwood with preservatives
Wyniki nasycenia środkami ochrony twardzielowego drewna topolowego

Preservatives Środki ochrony	Moisture content, % Wilgotność drewna, %	Time of immersion Czas kąpieli min.	Depth of penetration, mm Głębokość wnikania, mm			Retention, g/m2 Ilość soli, g/m2		
			minim. minim.	max. max.	mean śred.	minim. minim.	max. max.	mean śred.
1	2	3	4	5	6	7	8	9
Biotox R-12	12	15	1.5	3.9	2.5	12.5	23.8	17.8
		30	1.3	5.0	3.0	16.3	22.5	20.3
		60	1.7	5.0	3.0	11.3	17.5	14.5
	28	15	1.9	4.9	3.1	6.3	8.8	7.8
		30	2.1	5.1	3.4	10.0	18.8	13.7
		60	2.2	5.2	3.8	10.0	12.5	11.0
	50	15	4.0	9.5	6.8	3.8	7.5	4.8
		30	5.0	7.0	7.3	7.5	10.0	8.8
		60	5.2	6.4	7.8	8.8	12.5	9.8
Preparation CF Preparat CF	12	15	0.9	4.0	2.0	20.0	31.3	24.8
		30	0.9	6.2	2.5	30.0	40.0	35.5
		60	1.3	5.5	3.0	33.8	50.0	41.0
	28	15	0.9	6.2	2.5	11.3	20.0	14.3
		30	1.0	6.0	2.8	16.3	27.5	20.5
		60	1.3	7.2	3.6	16.3	28.8	22.8
	50	15	1.5	7.2	3.8	3.8	8.8	6.8
		30	1.1	7.1	4.5	5.0	8.8	7.0
		60	2.7	11.0	5.7	7.5	11.3	9.3
Preparation F-8 Preparat F-8	12	15	0.9	5.8	2.4	18.8	38.8	32.6
		30	1.2	8.0	3.4	35.0	61.3	51.8
		60	0.9	6.2	2.8	31.3	42.5	36.0
	28	15	1.3	8.0	3.7	13.8	22.5	18.8
		30	1.5	6.6	4.1	16.3	26.3	20.5
		60	1.9	10.0	4.8	18.8	35.0	26.3
	50	15	1.5	9.0	3.9	5.0	11.3	7.3
		30	1.2	8.0	4.1	7.5	10.0	8.3
		60	2.2	12.5	6.7	6.3	10.0	8.3
Preparation SF Preparat SF	12	15	0.8	4.0	1.7	12.5	20.0	16.8
		30	0.9	4.1	1.7	16.3	26.3	21.0
		60	0.9	4.9	1.9	20.0	27.5	24.0
	28	15	0.7	2.6	1.4	8.8	13.8	10.8
		30	0.5	5.8	1.7	11.3	13.8	13.0
		60	0.6	3.7	1.7	10.0	13.8	12.5
	50	15	1.2	5.1	2.5	5.0	11.3	7.3
		30	1.2	4.6	2.5	7.5	11.3	9.5
		60	1.7	6.5	3.2	6.3	13.8	9.0

1	2	3	4	5	6	7	8	9
Preparation BS Preparat BS	12	15	0.8	8.5	3.4	20.0	35.0	27.0
		30	2.1	8.5	4.6	36.3	46.3	42.3
		60	1.9	10.0	4.8	38.8	67.5	46.0
	28	15	1.0	7.0	3.8	11.3	15.0	13.0
		30	2.5	7.2	4.6	15.0	27.5	19.5
		60	1.5	9.0	5.7	23.8	32.5	28.8
	50	15	6.5	12.0	9.4	3.8	6.3	5.3
		30	8.5	15.0	11.7	10.0	16.3	11.8
		60	20.0	20.0	20.0	5.0	8.5	7.5
Coal tar creosote Olej impregnacyjny	12	15	0.5	7.2	2.9	125.0	212.5	160.0
		30	0.5	8.0	3.6	137.5	487.5	203.0
		60	1.0	8.0	4.3	212.5	350.0	297.5
	28	15	0.3	5.4	1.8	87.5	162.5	127.5
		30	0.5	7.1	2.4	87.5	125.0	112.5
		60	0.9	6.2	3.4	175.0	275.0	221.9
	50	15	0.0	0.9	0.2	25.0	87.5	50.0
		30	0.0	0.6	0.2	37.5	62.5	50.0
		60	0.1	1.1	0.3	62.5	75.0	65.0

CONCLUSION

The depth of penetration of waterborne preservatives and coal tar creosote into heartwood has been very close as into sapwood

The retention of preservatives by heartwood has been bigger than by sapwood. These results allow to come to the following conclusion - the permeability of poplar sap- and heartwood are nearly the same.

Received in November 1994

REFERENCES

1. Bażenow W. A., Moskalewa W. E.: O pronicajemosti driewiesiny zabołoni i jadra sosny. Trudy Instituta Lesa 1953, 9.
2. Becker G., Berghoff W.: Über die Verteilung und das Verbleiben von FluorVerbindungen in Kiefernholz im Laufe langerer Zeit. Holz als Roh.-u. Werkstoff 1965 347-354.
3. Bellmann H.: Über den Einfluss der Tüpfelkapillaren und Micellarinterstizien auf die Mechanik von Imprägniervorgangen mit Losungen. Mitt. Bund. Forsch. Anst. Forst. u. Holzwirtschaft 1955, 37, 64.
4. Buro A., Buro E. A.: Beitrag zur Kenntnis der Eindringwege fur Flüssigkeiten in Kiefemholz. Holzforschung1959,13, 71-77.
5. Gohre K.: Versuche zur Imprägnierung von Kiefernholz mit Teerol. Holz als Rohu. Werkstoff 1958,16, 22-27.
6. Körting A.: Über die Vorbeugende Wirkung von Holzschutzmitteln gegen den Hausbockkäfer in der Praxis. Holz als Roh-u. Werkstoff 1958,16, 377-383.

7. L i e s e W.: Die Feinstruktur des Holzes und ihr Einfluss auf die Imprägnierung. Holzindustrie 1956, 8,1-6.
8. R u d m a n P.: Studies in Wood Preservation. Pt. III. The Penetration of the Fine Structure of Wood by Inorganic Solution including Wood Preservatves. Holzforschung 1966, 20, 60-67.
9. V a n A c k e r J., S t e v e n s M., D e H a a s C.: Influence of clonal variability on the impregnability of poplar hybrids. The IRG on Wood Preservation. Working Group III, Preservatives and Methods Treatment 1990, Doc. No. IRGIWPl3614.
10. W y t w e r T.: Badania nad wpływem niektórych czynników na wnikanie środków impregnacyjnych w biel drewna sosny. Folia Forestalia Polonica s. B, 1966, z. 7, 83-105.
11. W y t w e r T.: Badania nad wnikaniem środków grzybobójczych w twardziel drewna sosny. Folia Forestalia Polonica, s. B 1968, z. 8, 69-82.
12. W y t w e r T.: Badania nad wnikaniem środków grzybobójczych do drewna świerkowego. Folia Forestalia Polonica, s. B, 1971, z. 10, 107-132.
13. W y t w e r T.: Mechanizm wnikania nieorganicznych związków grzybobójczych do bielu drewna sosnowego. Zeszyty Naukowe Akademii Rolniczej w Warszawie. Rozprawy Naukowe 1975, 47.
14. W y t w e r T.: Środek grzybobójczy do ochrony materiałów budowlanych. Patent nr 138070,1986 a
15. W y t w e r T.: Środek ochrony drewna. Patent nr 139384, 1986 b.
16. W y t w e r T.: Środek ochrony drewna i materiałów lignocelulozowych. Patent nr 144217, 1987.
17. W y t w e r T.: Środek ochrony drewna przed biokorozją. Patent nr 158853, 1992.
18. PN-75/C-04901. Środki ochrony drewna. Oznaczanie głębokości wnikania w drewno.

WNIKANIE ŚRODKÓW OCHRONY DO DREWNA TOPOLOWEGO

Streszczenie

Przeprowadzono badania nad wnikaniem 5 środków solnych i jednego oleistego do drewna topolowego. Próbki drewna wykonane z bielastego i twardzielowego drewna topolowego nasycano w roztworach wodnych solnych środków o stężeniu 10%. Wilgotność próbek drewna była zróżnicowana i wynosiła 12, 28 i 50%. Próbki nasycono metodę, kąpieli, trwającą 15, 30 i 60 min. Głębokość wnikania środków ochrony do bielu i twardzieli drewna topolowego była zbliżona. Wzrost wilgotności drewna zwiększał głębokość wnikania środków solnych i zmniejszał głębokość wnikania środka oleistego, szczególnie w przedziale wilgotności 28-50%. Stosowanie dłuższych czasów kąpieli zwiększało, nieregularnie głębokość wnikania i ilość pochłoniętych środków. Wyniki badań - głębokość wnikania i ilość pochłoniętych środków, przedstawiono w tabelach.

Authors address:
Prof. dr hab. Tadeusz Wytwer
Katedra Ochrony Drewna SGGW
02-528 Warszawa, ul.Rakowiecka 26/30