FOLIA FORESTALIA POLONICA
seria B, zeszyt 31, 2000

CHANGES OF COPPER AND CHROMIUM CONTENT IN WOOD IMPREGNATED WITH THE CCB AND CB PRESERVATIVES AFTER LEACHING[1]

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The objective of the study was impregnated with CCB and CB preservatives pine wood of moisture content varying from 12 to 55% subjected to leaching. Losses of copper and chromium were determined for individual layers of wood up to 3 cm from the girth. The results were compared to the total amount of metals determined in water extracts. The concentration of copper and chromium ions in samples was determined after mineralization in an microwave oven with the use of atomic absorption spectrophotometry (AAS). The obtained results (ppm) were recalculated into contents of individual components of the mixture in consecutive layers of wood (kg/m^3) taking into account their percentage contents in the mixture.

Key words: leachability, CCB and CB wood preservatives, AAS analysis, copper, chromium

INTRODUCTION

The decrease of preservation degree of wood impregnated with chemical preservatives may be a result of leaching of water soluble components of a preservative. When investigating changes of contents of preservatives components in wood caused by outer factors, a possible identification and monitoring of physical aspects of leaching mechanism in wood is very difficult. The degree of leaching of active components is

[1] The research was financed by the Polish State Committee for Scientific Research – the research project 7 T08E 076 18. Paper presented on the IRG on Wood Preservation 31 Annual Meeting in Kona USA, the 14– 19 May 2000.

strongly related to dimensions of tested samples or more precisely to the ratio surface-volume (Leuritz 1968; Miller 1972). The remaining factors influencing the amount of leached components from impregnated wood depend on the degree of absorption and distribution of preservative concentration in wood as well, as on wood permeability and technological parameters of the impregnation process (Cockroft and Laidlaw 1978).

The degree of leaching of preservative components is determined by the composition of the chemical agent, which directly influences the run of the reaction of fixing of the impregnant in wood. Temperature, wood moisture content and its duration also influence fixing (Lee, Grafton and Tainter 1993).

It is supposed that components of a preservative do not undergo leaching in middle and large sized wood. However, in practice the components do not undergo leaching in such a high degree as from laboratory samples used in tests according to the standard EN 84. It is even because of the lower ratio of the exposed surface to wood volume (Lee, Grafton and Tainter 1993). The application of small size samples in laboratory tests aims to shorten duration of leaching cycle. Undoubtedly, it allows analysing behavior of different types of impregnants as well as susceptibility of individual ions for leaching. Nevertheless, results of that kind of research can not be extrapolated in order to predict the degree of leaching from full size wood impregnated with industrial technologies (Melcher and Wegen 1999; Yamamoto, Motegi and Inai 1999; Willeitner and Peek 1998).

In the presented study samples of much higher size were used than that in traditional laboratory tests. The form of the samples was close to wood impregnated in the industrial scale i.e. their cross-section was round. The shape of samples also let to monitor effectively distribution of the investigated active ion in the cross-section of wood as well as changes of its concentration caused by leaching. It let simulate significantly practical conditions.

The main goal of the work was investigation of leaching dynamics of metal ions from middle-sized wood impregnated with CCB and CB preservatives. It consisted in showing the relationship between the amount of copper and chromium ions transferred from wood to a solution and ions concentration in individual layers of wood taking into account duration of leaching process divided into 9 stages in 14 days.

MATERIALS

Preservatives:

Two preservatives were used during studies. The first one preservative was of the CCB type containing 36% of $CuSO_4$, 40% of $K_2Cr_2O_7$, 24% of H_3BO_3. The second of the CB type consisted of 15% of CuO, 5% of H_3BO_3 and ca. 0.5% of Tebuconazolu (α-[2-(4-chlorophenyl)ethyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazolyl-1-ethanol). The preservatives were used to prepare water solutions of concentration of 2% for wood impregnation.

Table 1
Tabela 1

Dimensions of samples and parameters macroscopic structure of wood*
Wymiary próbek oraz parametry budowy makroskopowej*

Wood moisture content level Poziom wilgotności drewna [%]	Diameter Średnica [mm]	Number of yearly growth rings in a radius Liczba słojów rocznych na promieniu	Mean width of a yearly ring Przeciętna szerokość słoju rocznego [mm]	Sapwood content in the cross-section Udział strefy bielastej na powierzchni przekroju poprzecznego [%]
12	84.8 (5.1)	21 (3)	2.0 (0.3)	82.0 (5.0)
28	102.4 (6.8)	19 (2)	2.7 (0.3)	86.6 (14.5)
55	82.7 (4.6)	16 (4)	2.7 (0.6)	81.3 (11.2)

*The values are arithmetic means of 10 tests, values in brackets represent standard deviations
*Wartości stanowią średnie arytmetyczne z 10 prób; wartości w nawiasach przedstawiają odchylenie standardowe

Wood:

Scots pine wood (*Pinus sylvestris* L.) was used as material for investigations. Samples had shape of rollers of the length of 250 ± 10 mm. Diameters and other basic data on macroscopic structure of wood are presented in Table 1.

METHODS

Samples after their obtaining and debarking were stored in controlled conditions in order to obtain moisture contents of ca. 55, 28 and 12%. There were prepared 10 samples for each preservative and moisture content level. Fronts of samples i.e. cross-section surfaces were protected against penetration of the solution along the grain. It was made by covering them with silicon resin. Wood impregnation was carried out with the full-cell vacuum method with 85 hPa of vacuum. The duration of vacuum was 20 min. Time of wood staying in impregnant solution under the atmospheric pressure was 2 hrs. As the result of impregnation there was obtained absorption of preservative of 2.3 to 10.7 kg/m^3 (Table 2).

After 14 days of samples conditioning in air of relative humidity of ca. 98% samples were subjected to leaching. It was preceded by impregnation with distilled water using the full cell vacuum method similarly as during impregnation with tested chemical agents. Samples after impregnation with water were moved to containers with fresh water of the amount of 5 volumetric parts to 1 volumetric part of wood. The proportion of water to wood was according to the standard EN 84 during testing leaching of preservatives with biological method. Samples remained immersed in water for period of 14 days. Water was exchanged every day during first 4 days and next every second days at the same time. The total number of water exchange was 9. During that time a sample of water was taken in order to perform its analysis. The amount of ac-

Table 2
Tabela 2

Results of wood impregnation as values of preservative absorption*
Wyniki nasycania drewna jako wartość wchłonięcia preparatu*

Type of Preservative Typ preparatu	Wood moisture content Wilgotność drewna [%]	Mean salt content in wood Średnia zawartość soli w drewnie [kg/m^3]	
		In whole volume W całej objętości	In sapwood W strefie bielu
CCB	12	10.7 (0.7)	13.0
	28	8.8 (1.4)	10.2
	55	4.1 (0.6)	5.0
CB	12	5.2 (4.8)	7.2
	28	7.5 (1.9)	10.9
	55	2.3 (0.5)	3.3

* The values are arithmetic means of 10 tests, values in brackets represent standard deviations
* Wartości przedstawiają średnie z 10 prób; wartości w nawiasach przedstawiają odchylenie standardowe

tive ions of copper and chromium leached from was determined in water extracts from consecutive stages of leaching with the spectrophotometric method (AAS).

From each roller before and after leaching there were taken 8 samples with the use of the Pressler drill of the diameter of 5 mm. Samples were taken according to the general scheme allowing to obtain repeatability of locations of samples taking (Lutomski and Mazela 1999). Every 8 samples obtained after drilling were cut with a lancet into 1 mm thick sections for the first 2 mm of a sample length and into 10 or 15 sections of thickness of 2 mm depending on the width of impregnated zone. The concentration of copper and chromium ions in samples was determined after mineralization in an microwave oven with the use of atomic absorption spectrophotometry (AAS) using the Varian AA-20 spectrometer. The obtained results (ppm) were recalculated into contents of individual components of the mixture in consecutive layers of wood (kg/m^3) taking into account their percentage contents in the mixture.

RESULTS

Change of copper and chromium ions content in individual layers of wood after drying

Wood of the initial moisture content of ca. 12%.

The mean absorption of copper by samples impregnated with the CCB preservative was 2.02 kg/m^3. After finishing leaching the content of copper was identified as equal to 1.98 kg/m^3. The leaching degree determined from the difference of copper concentration in wood before and after leaching was 2%.

The analysis of copper content in consecutive wood layers towards the heartwood zone revealed differentiated losses of the ions in the range from near-surface layers to 2 mm depth (2.06 kg/m^3). Beginning from 4 mm there was observed small increase of

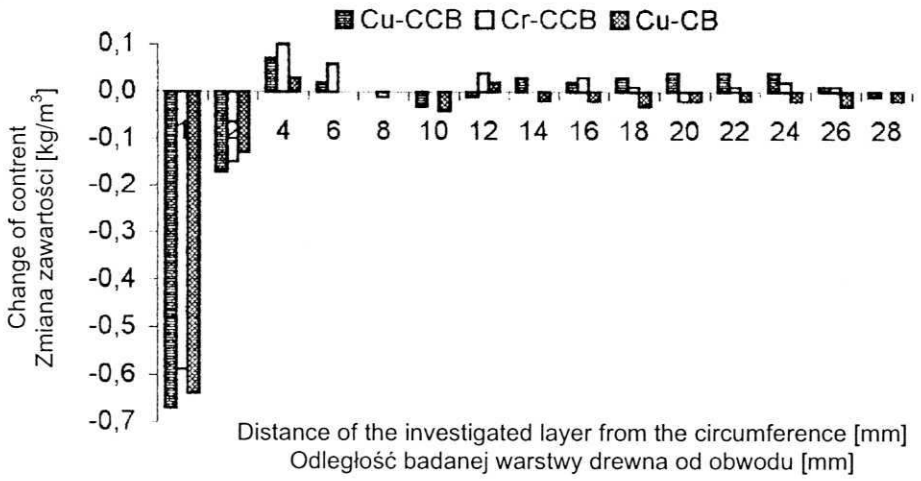

Fig. 1. Differences of copper and chromium content in consecutive layers of wood caused by leaching (12% wood moisture content before treatment)
Rys. 1. Różnica zawartości miedzi i chromu w poszczególnych warstwach drewna w wyniku procesu wymywania (wilgotność drewna przed nasycaniem 12%)

copper content of ca. 0.1-0.5 kg/m^3. The percentage loss of copper ions for the first and second layer was 15.6 and 4.2% separately (Fig. 1).

The mean values of chromium absorption for the series of 10 test was 3.30 kg/m^3. Chromium content after leaching decreased of 1% in the investigated zone of wood. The analysis of chromium content in consecutive layers of wood gave similar results as in the previous case. The loss of chromium ions was related to the layer of 2 mm. The percentage loss of chromium content in the first and the second layer was 9.4 and 2.7% respectively. Below that depth there was observed small increase of chromium ions content.

The mean values of copper adsorption for wood impregnated with the CB preservative was 0.79 kg/m^3. After leaching the value decreased to 0.06 kg/m^3 that is the loss was of ca. 7.8%. Similarly as for wood impregnated with the CCB preservative changes of copper content in the first zone of wood are on the similar level. Copper content decreased to ca. 0.65 kg/m^3 that is ca. 18.6% in the depth of 1 mm and 6.0% in the depth of 2 mm. Changes of copper content in consecutive layers had the similar run as for impregnation with the CCB preservative.

Wood of the initial moisture content of ca. 28%.

The mean adsorption of copper in a layer of 28 mm from the girth towards the pith was 2.42 kg/m^3 for wood of moisture content of 28% during impregnation. After leaching there was observed loss of copper of 9.6% in the zone of wood under investigations. Losses of copper reached the depth of 20 mm from wood surface (Fig. 2). Below the depth of 22 mm there was observed little increase of copper concentration in consecutive layers. The mean difference of copper content in the first layer under investiga-

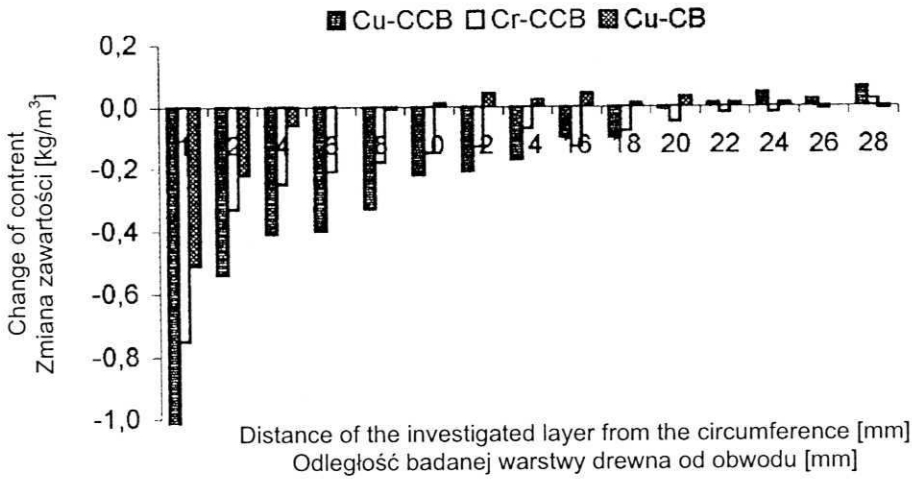

Fig. 2. Differences of copper and chromium content in consecutive layers of wood caused by leaching (28% wood moisture content before treatment)
Rys. 2. Różnica zawartości miedzi i chromu w poszczególnych warstwach drewna w wyniku procesu wymywania (wilgotność drewna przed nasycaniem 28%)

tions caused by leaching was ca. 21.6% i.e. 4.85 kg/m^3. The difference was gradually decreasing in consecutive layers.

The difference between the mean value of absorbed chromium and the mean chromium content after leaching was 0.16 kg/m^3 that is the leaching degree is 6.6% in the investigated layer of wood. Similarly as for copper beginning from the near-surface through next layers the value of the degree of leaching was decreasing to the depth of 22 mm.

The comparison of mean values of leaching of copper and chromium ions for wooden samples of moisture contents of 12 and 28% revealed strongly higher degree of leaching of both metals from wood of higher initial moisture content.

The degree of leaching of copper within the analysed zone of wood impregnated with the CB preservative was equal to ca. 6%. The decrease of copper content at the depth of 1 and 2 mm related to the state before leaching was 15 and 10% respectively that is the loss of ca. 0.5 and 0.2 kg/m^3 (Fig. 2).

Wood of the initial moisture content of ca. 55%.

The mean adsorption of copper by wood of moisture content of 55% impregnated with the CCB preservative was 0.94 kg/m^3. After leaching the concentration of copper ions decreased to the value of 0.12 kg/m^3 in the layer of 3 mm of the investigated zone of wood. That is the ion loss was equal to ca. 12.5%. It is the highest degree of leaching from among analysed variants of tests.

The analysis of the difference of copper ions content in individual layers of wood shows that the phenomenon of leaching of copper concerns wood layers up to 6 mm of

depth. It is because in this zone of wood was observed distinct decrease of copper content (Fig. 3). The percentage decrease of copper content in four consecutive layers was 15.8, 17.0, 15.7 and 14.8% respectively.

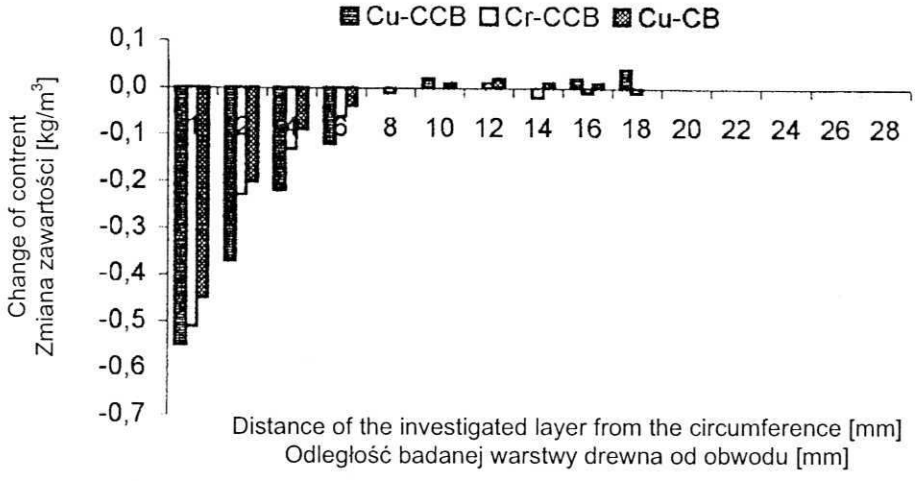

Fig. 3. Differences of copper and chromium content in consecutive layers of wood caused by leaching (55% wood moisture content before treatment)
Rys. 3. Różnica zawartości miedzi i chromu w poszczególnych warstwach drewna w wyniku procesu wymywania (wilgotność drewna przed nasycaniem 55%)

Table 3
Tabela 3

Leaching degree of Cu and Cr ions from wood impregnated with the CCB and CB preservatives determined in relation to absorption of individual ion*
Stopień wymycia jonów Cu i Cr z drewna nasyconego preparatem CCB i CB określony względem poziomu wchłonięcia poszczególnych jonów*

Initial moisture content level of wood Poziom wilgotności początkowej drewna [%]	Type of preservative Typ preparatu	Investigated ion Badany jon	Absorption Wchłonięcie [kg/m^3]	Total amount of leached ions Suma wymytych jonów [ppm]	Degree of leaching Stopień wymycia [%]
12	CCB	Cu	2.0 (0.3)	27.9 (6.2)	0.7
		Cr	3.3 (0.3)	18.8 (6.3)	0.3
	CB	Cu	0.8 (0.6)	24.2 (15.9)	1.9

* The values are arithmetic means of 10 tests, values in brackets represent standard deviations
* Wartości przedstawiają średnie z 10 prób; wartości w nawiasach przedstawiają odchylenie standardowe

The degree of ion leaching from the wood zone of width of ca. 28 mm was 11%. The decrease of chromium content in individual depths of wood is characterised by the similar run as for copper ions leaching. The percentage loss of ions from wood from the depth of 1 mm and 2 mm was 15.6 and 13.7% respectively. For the next 4 mm it was 11.5 and 8.2% respectively.

Wood of the initial moisture content of ca. 55% impregnated with the CB preservative absorbed on average 0.36 kg/m^3 of copper. It is the lowest value of absorbed copper from all analysed variants of investigations. Simultaneously, it is characterised by the highest degree of leaching of copper ions, i.e. 19.8%. The difference of copper content in the depth up to 2 mm was ca. 0.45 and 0.20 kg/m^3 respectively. Recalculating it into relative values gives 19.6 and 26.8% (Fig. 3).

Content of copper and chromium ions content in water extracts from leaching of pine rollers

Wood of the initial moisture content of ca. 12%.

The degree of leaching of copper from rollers impregnated with the CCB preservative at moisture content of 12% was equal 0.7% in the relation to the mean absorption of copper of 2.02 kg/m^3. The above results are presented in Table 3.

The total amount of copper ions during the cycle of 14 days of leaching consisting of 9 stages was 27.9 ppm. The range of copper contents in water extracts was from 10.1 ppm in the first stage to 1.6 ppm in the last ninth stage of leaching. The amounts of copper leached in individual stages of the process are presented in Fig. 4 and can be represented by the exponential function of the form: $y = a+b/x^2$.

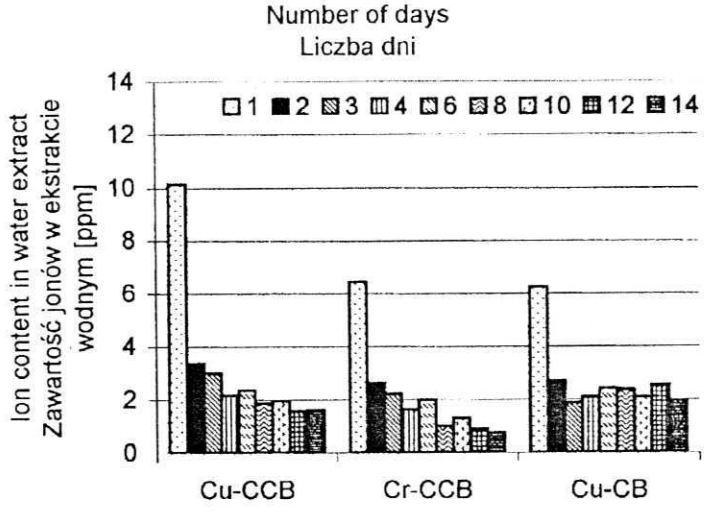

Fig. 4. Dynamics of copper and chromium leaching from wood impregnated with CCB and CB preservatives at moisture content of 12%

Rys. 4. Dynamika wymywania miedzi i chromu z drewna nasycanego preparatem typu CCB i CB w stanie wilgotności 12%

Leaching of chromium was ca. 0.3% for the same group of tests at the mean value of chromium adsorption of 3.3 kg/m^3. It was over two times smaller degree of leaching in comparison to copper leaching. The sum amount of leached chromium ions was 18.8 ppm. The extreme values on the beginning and the end of the leaching cycle were from 6.5 to 0.7 ppm.

For wood impregnated with the CB preservative the degree of leaching of copper ions was 1.9% in relation to the amount of absorbed copper of 0.79 kg/m^3. The sum of leached ions was 24.2 ppm. Concentration of leached copper ions in the water extract was decreasing from 6.2 ppm on the beginning to 2.0 ppm on the end stage of the process that is to ca. 2/3 of the initial value (Fig. 4).

Wood of the initial moisture content of ca. 28%.

For the case of samples of moisture content of 28% impregnated with the CCB preservative the degree of copper adsorption was 2.42 kg/m^3. The value was slightly higher than that for wood of the initial moisture content of 12%. The degree of leaching related to the adsorption was equal 1.2% (Table 4). The sum of leached copper ions was 55.4 ppm and the range of contents between the first and the last stage of leaching was 12.3÷4.6 ppm.

The absorption of chromium was 2.4 kg/m^3 while its degree of leaching was 0.2%. In comparison to leachability of copper the degree of chromium leaching was six times lower. The value of 7.9 ppm Cr was the total amount of ions leached during the whole cycle of leaching. The chromium ions concentration in consecutive stages of leaching was decreasing from 2.1 to 0.9 ppm (Fig. 5).

The series of samples impregnated with CB at moisture content of ca. 28% characterised with higher degree of copper leaching (2.4%) in the relation to absorption determined as equal to 0.72 kg/m^3. The sum of leached copper ions was ca. 33.3 ppm. Concentration of chromium ions in individual stages was decreasing from 8.3 to 2.4 ppm (Table 4, Fig. 5).

Wood of the initial moisture content of ca. 55%.

Wood of moisture content of 55% was impregnated with the CCB preservative up to the level of 0.94 kg/m^3. It was characterised by higher degree of copper ions leaching which was 2.1%. The sum of leached ions was 37.9 ppm and the range of amount of extracted ions was from 10.5 to 2.3 ppm. The mean degree of chromium leaching at the mean degree of absorption equal to 0.83 kg/m^3 was determined as equal to 0.7%. The sum of leached ions was 11.2 ppm and concentration of chromium ions in individual stages was decreasing from 4.9 to 0.2 ppm (Table 5, Fig. 6).

The biggest degree of copper leaching i.e. 5.7% was observed for the series of samples of the lowest absorption of the CB preservative (0.36 kg/m^3). It can be related among others to high moisture content during impregnation. The sum of leached ions was 39.4 ppm. Concentration of copper ions in consecutive stages of leaching was in the range from 9.6 to 2.3 ppm (Fig. 6).

In all described above cases strongly the biggest degree of leaching was observed in the first stage that is in the first day of leaching. The amount of extracted ions in consecutive stages was significantly decreasing. The values can be described by the exponential function of the form: $y = a+b/x^2$ (Fig. 6).

Table 4
Tabela 4

Leaching degree of Cu and Cr ions from wood impregnated with the CCB and CB preservatives determined in relation to absorption of individual ions*
Stopień wymycia jonów Cu i Cr z drewna nasyconego preparatem CCB i CB określony względem poziomu wchłonięcia poszczególnych jonów*

Initial moisture content level of wood Poziom wilgotności początkowej drewna [%]	Type of preservative Typ preparau	Investigated ion Badany jon	Absorption Wchłonięcie [kg/m^3]	Total amount of leached ions Suma wymytych jonów [ppm]	Degree of leaching Stopień wymycia [%]
28	CCB	Cu	2.4 (0.8)	55.4 (7.2)	1.2
		Cr	2.4 (0.7)	7.9 (3.1)	0.2
	CB	Cu	0.7 (0.2)	33.3 (5.7)	2.4

* The values are arithmetic means of 10 tests, values in brackets represent standard deviations
* Wartości przedstawiają średnie z 10 prób; wartości w nawiasach przedstawiają odchylenie standardowe

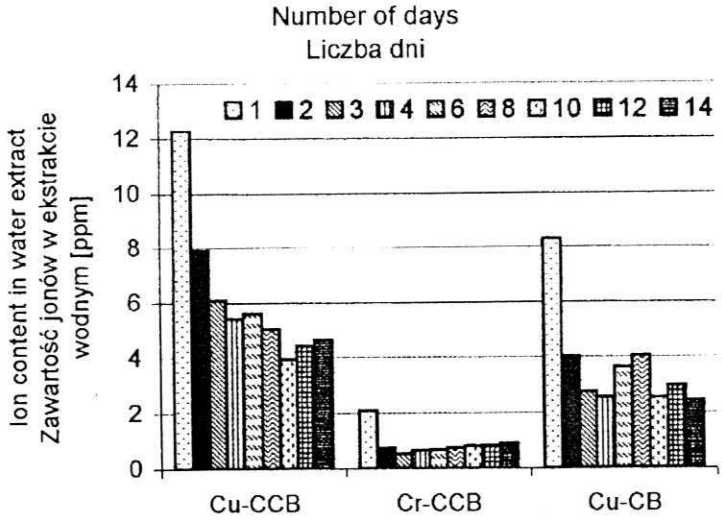

Fig. 5. Dynamics of copper and chromium leaching from wood impregnated with CCB and CB preservatives at moisture content of 28%
Rys. 5. Dynamika wymywania miedzi i chromu z drewna nasycanego preparatem typu CCB i CB w stanie wilgotności 28%

Table 5
Tabela 5

Leaching degree of Cu and Cr ions from wood impregnated with the CCB and CB preservatives determined in relation to absorption of individual ions*
Stopień wymycia jonów Cu i Cr z drewna nasyconego preparatem CCB i CB określony względem poziomu wchłonięcia poszczególnych jonów*

Initial moisture content level of wood Poziom wilgotności początkowej drewna [%]	Type of preservative Typ preparau	Investigated ion Badany jon	Absorption Wchłonięcie [kg/m^3]	Total amount of leached ions Suma wymytych jonów [ppm]	Degree of leaching Stopień wymycia [%]
55	CCB	Cu	0.9 (0.3)	37.9 (8.7)	2.1
		Cr	0.8 (0.1)	11.2 (3.7)	0.7
	CB	Cu	0.4 (0.1)	39.4 (5.1)	5.7

* The values are arithmetic means of 10 tests, values in brackets represent standard deviations
* Wartości przedstawiają średnie z 10 prób; wartości w nawiasach przedstawiają odchylenie standardowe

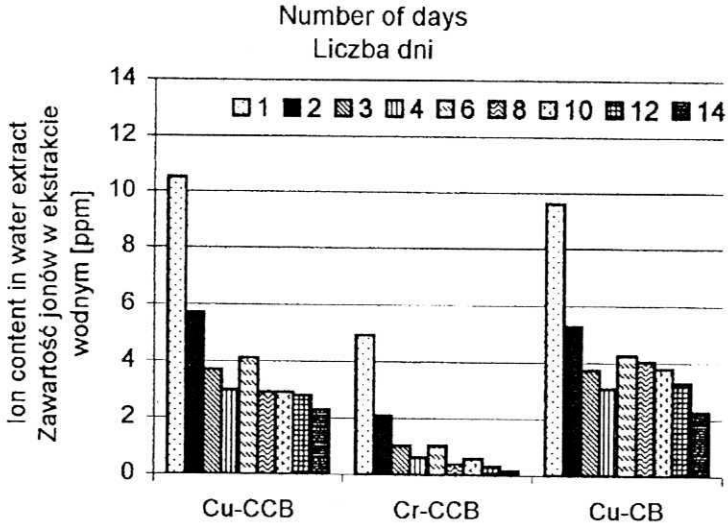

Fig. 6. Dynamics of copper and chromium leaching from wood impregnated with CCB and CB preservatives at moisture content of 55%
Rys. 6. Dynamika wymywania miedzi i chromu z drewna nasycanego preparatem typu CCB i CB w stanie wilgotności 55%

DISCUSSION

As mentioned in the description of methods the degree of leaching of copper and chromium from wood impregnated with investigated preservatives was determined by two different techniques using instrumental analysis. The first one consisted in determining losses of both metals from wood caused by leaching. The degree of leaching was expressed by the value of the decrease of content of copper and chromium in individual layers related to the state before leaching. There was also determined the mean degree of leaching resulting from the difference between the mean value of adsorption of copper and chromium compounds during impregnation and the mean value of their contents after leaching. The analysis of the obtained results let to obtain the relationship between the degree of leaching and wood moisture content before impregnation. The percentage losses of copper and chromium in the relation to the initial state were increasing for both preservatives with the increase of the initial moisture content of wood. The above relationship can be explained by the higher concentration of components of preservatives in near-surface layers of wood at general lower absorption being the result of higher initial moisture content. Moreover, for the three moisture contents of impregnated wood with the CCB preservative the loss of copper ions was always higher than the chromium ion loss.

The second technique of the leaching degree determination was based on the quantitative analysis of water extract obtained from leaching of wooden samples in consecutive stages of the process. Similarly as for the previous technique there was observed higher degree of leaching of the investigated ions for samples of higher initial moisture content. The both techniques revealed similar trends in amounts of leached components depending on the type of preservative as well as on their chemical form and the initial moisture content of wood. In spite of that the values of leaching degree differ for the same variants of tests. Significantly higher degree of leaching was obtained when expressing it as the loss of investigated metals in wood. The reason was that the first technique the analysis was performed for the 28 mm layer of wood and the leaching degree was calculated for that volume of wood. The leaching degree established with the use of the second technique was related to the total volume of wood subjected to leaching and depended on the earlier established ratio of volume of leaching agent to volume of a leached sample.

In order to compare the above results with results of other authors there is a need to take into account that the investigations on leachability were performed for different technological parameters resulting from different methods which significantly differentiated the obtained values. From the earlier works on leachability of salt preservatives from middle-size wood it is worth mention works of Zycha (1958), Gersonde (1959), Wischer (1976), Evans (1987), Illner (1988), Klipp et al. (1991), Klipp and Brandt (1992), Willeitner et al. (1991), Lutomski and Mazela (1997, 1999). Table 6 presents the comparison of results from this work with results of other authors.

As it results from the above table the mean degree of copper leaching from wood impregnated with CKB and CKF preservatives was higher in comparison to

the degree of chromium leaching. Moreover, it was also stated the significantly higher degree of copper leaching from wood impregnated with the non-chromium preservative in comparison to the other two cases. The above relationship, which was also proved by this work, may be explained by the known from literature ability of chromium compounds to bond copper in wood (Dahlgren 1972).

Table 6
Tabela 6

The mean degree of leaching of Cu and Cr from middle-size wood at different time of exposure, per cents of absorption
Średni stopień wymycia Cu i Cr z drewna średniowymiarowego przy zróżnicowanym czasie ekspozycji, wyrażony w procentach ilości wchłoniętej

Type of preservative[a] Typ preparatu	Number of years Liczba lat	Cu [%]	Cr [%]
CKB	1	0.90	0.19
	2	0.24	0.11
	3	0.44	0.18
CKF	1	1.23	1.01
	2	0.15	0.11
	3	0.34	0.15
Cu-HDO	1	11.8	-
	2	1.1	-
	3	1.5	-

Type of preservative[b] Typ preparatu	Number of months Liczba miesięcy	Cu [%]	Cr [%]
CCA	6	2.0÷2.5	0
ACQ		26.2÷26.3	-

Type of preservative[c] Typ preparatu	Number of days Liczba dni	Cu [%]	Cr [%]
CCB	14	0.7÷2.1	0.2÷0.7
CB		1.9÷5.7	-

[a] Acc. to Klipp and Brandt (1992)
[a] Wg Klipp'a i Brandt'a (1992)
[b] Acc. to Yamamoto (1999), results from the testing ground
[b] Wg Yamamoto (1999), z badań poligonowych
[c] Acc. to own investigations
[c] Wg badań własnych

FINAL REMARKS

The performed research shows that the degree of leaching from wood of components of preservatives is closely related to concentration of a preservative in individual layers of wood. It is directly related to wood moisture content before impregnation. Higher concentration of preservative in small depths is the effect of impregnation of wood of higher initial content. Because the leaching phenomenon concerns first of all the near-surface layer, hence the degree of leaching for wood of higher moisture content during impregnation (55%) was higher than in the other variants. Wood of lower moisture content before impregnation (28 and 12%) was characterised by more uniform impregnation of sapwood. It significantly influenced the decrease of the leaching degree of components of preservatives. The degree of leaching expressed as the loss of copper and chromium ions from impregnated wood is in all cases higher than the degree of leaching determined as the amount of extracted metal ions (Table 7). The relationship can be explained by the probable phenomenon of displacing of some amounts of metal ions into deeper layers of wood, which were not subjected to the analysis ion content.

Table 7
Tabela 7

Summary of results of the degree of copper and chromium leaching from wood impregnated with CCB and CB preservatives
Zestawienie wyników oznaczania stopnia wymycia miedzi i chromu z drewna nasycanego preparatami typu CCB i CB

Level of wood moisture content Poziom wilgotności drewna [%]	Loss of ions from wood Ubytek jonów z drewna [%]			Content of leached ions in water Zawartość wymytych jonów w wodzie [%]		
	CCB		CB	CCB		CB
	Cu	Cr	Cu	Cu	Cr	Cu
12	2.0	1.0	7.8	0.7	0.3	1.9
28	9.4	6.6	5.9	1.2	0.2	2.4
55	12.6	11.0	19.8	2.1	0.7	5.7

CONCLUSIONS

1. The differentiated absorption of CCB and CB preservatives by wood depending on its initial moisture content influences significantly leachability of preservatives' components from wood.

2. The dynamics of copper and chromium leaching from impregnated wood is characterised by the intensive run in the initial stage of the process. In the first stage there is leached 25 to 45% of total amount of metal ions extracted from wood.
3. The degree of leaching of copper and chromium from wood impregnated with the CB preservative is for the majority of cases 1.5 to 4 times higher in comparison with leaching from wood impregnated with the CCB.
4. Copper leachability from wood impregnated with the CCB preservative is significantly higher than chromium leachability. The difference in leachability of both metals decreases with the increase of initial moisture content.
5. Leaching of the investigated metals from wood impregnated with CCB and CB reaches the depth of 6 to 18 mm depending on their concentration in individual layers.

Received in March 2000

ACKNOWLEDGEMENTS

The author wishes to thank Ms. M. Bartkowiak and Mr. W. Grześkowiak from the Institute of Chemical Wood Technology, Agricultural University of Poznań for their contribution in experiments as well as the State Committee for Scientific Research for financial support of the work as the 7T08E07618 research grant.

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ZMIANY ZAWARTOŚCI JONÓW MIEDZI I CHROMU W DREWNIE IMPREGNOWANYM PREPARATAMI TYPU CCB I CB, PODDANYM WYMYWANIU

Streszczenie

Przedmiotem badań było impregnowane preparatami CCB i CB drewno sosny o wilgotności od 12 do 55%, poddane następnie procesowi wymywania. Oznaczono ubytki jonów miedzi i chromu w poszczególnych warstwach drewna sięgających 3 cm od obwodu. Wyniki porównano z sumaryczną ilością oznaczonych metali w ekstraktach wodnych. Stopień wymycia jonów metali z drewna o wilgotności początkowej 55% był wyższy niż w przypadku drewna powietrzno-suchego. Spektrofotometryczna analiza (AAS) poszczególnych warstw drewna, w niektórych przypadkach wykazała po wymywaniu wzrost stężenia jonów metali w warstwach głębiej usytuowanych.

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