

Preservative Leaching from Copper Azole–Treated Lumber: A Comparison between the Full-Cell Method and the Passive-Impregnation Method

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Abstract

This study investigated the leaching of copper azole (CA-B) preservative, according to JIS K 1571 standard, from sundri (*Heritiera fomes* Buch.-Ham.) lumber treated by full-cell and passive-impregnation methods. Although the preservative retention was similar for both methods, penetration was higher with the passive-impregnation method (66%) than with the full-cell method (43%). Further, it was found that the leaching of preservative was significantly higher in wood treated by the full-cell method (1.18%) than by the passive-impregnation method (0.92%).

Wood is used as a building material because it has many attractive features, such as renewability, high specific strength, relatively low price, and ease of production (Desch and Dinwoodie 1996). Lumber that is not naturally durable but used in applications where deterioration can occur should be treated to prevent decay by fungi, insects, mollusks, etc. The use of preservatives containing arsenic, chromium, and other heavy metals has decreased in most European countries and North America (Green and Clausen 2005, Humar et al. 2006). Moreover, there is an increasing public concern about environmental contamination from preservative-treated wood because of the leaching of toxic preservative components into the environment (Lebow and Tippie 2001, Lahiry 2003). The leaching of wood preservatives from treated wood can be affected by a number of factors, such as the wood properties, preservative-treatment method, and the properties of the water and soil substrate into which the treated wood is placed. These factors have been extensively studied (Kim and Kim 1993; Lebow et al. 1999; Lebow and Kartal 1999; Brown and Eaton 2000; Hingston et al. 2001; Kartal and Lebow 2001, 2002; Taylor and Cooper 2003; Kartal et al. 2007). The passive-impregnation method is a newly developed method for preserving all types of wood (Hattori et al. 2005; Islam

et al. 2007, 2008). In this method, steam is injected into laser-incised lumber, and the lumber is then dipped into preservative. It is more effective than the best currently existing method, i.e., the full-cell method (Islam et al. 2008), with respect to penetration and retention. However, the leaching of preservatives from wood treated with the passive-impregnation method has not yet been studied. Sundri (*Heritiera fomes* Buch.-Ham.), the dominant species (73%) of the Sundarbans (Khan et al. 2007), requires preservation for many timber applications. In this research, copper azole (CA-B) leaching from sundri treated by either the full-cell or passive-impregnation method was investigated.

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Forest Prod. J. 61(3):270–272.

Materials and Methods

Materials

The sundri heartwood lumber, a refractory mangrove species, used in this study had a basic density of 0.85 g/cm³ and moisture content of 25 percent. Long posts of square cross section (120 by 120 mm) were divided into two pieces and used for both the passive-impregnation and the full-cell treatment methods. These posts were cut to 650 mm in length and used as specimens for preservative treatment with CA-B. Both ends of the specimens were sealed with urethane resin prior to steam injection or full-cell treatment to prevent penetration of liquids from the ends.

Methods

The incising method by CO₂-laser and pattern (Fig. 1) was described by Islam et al. (2008) for both the passive-impregnation method and the full-cell method. Through-holes were made on a radial surface at a density of 10,000 holes per m². Moisture content was measured before and after treatment by oven drying (JIS Z 2101-1994; Japanese Industrial Standards [JIS] 1994).

For the passive-impregnation method, steam (steam temperature was 110°C for a hot plate temperature of 120°C) was injected into laser-incised lumber for 20 minutes using a steam injection press (VH2-1449; Kitagawa Seiki Co. Ltd.). Less than the standard treating conditions for the passive-impregnation method were used to produce a level of retention similar to that of the full-cell method. Immediately after steam injection, the specimens were dipped into 1.03% CA-B solution for 12 hours.

In the full-cell method, a vacuum (2.7 kPa) was drawn for 20 minutes. Thereafter, 1.03% CA-B solution was added, and the pressure was raised to 980.7 kPa and held there for 5 hours 30 minutes. After releasing the pressure, the excess liquid was drained, and the wood was subjected to a short vacuum (10 min) to hasten solution recovery. The total treating time was 6 hours 50 minutes. Each experiment was repeated at least three times.

Specimens for the penetration and leaching test were collected from the center of each treated sample. Preservative penetration (Cu) was measured based on the color indicator on the freshly cut wood surface of treated timber as described by the American Wood Preservers' Association (AWPA 2003) in both longitudinal and cross-sectional surfaces for all samples with the help of a scanner and Adobe Photoshop software (Islam et al. 2009). Total chemical retention (in kilograms per cubic meter) was determined by weighing each sample before and after treatment to determine solution uptake (Islam et al. 2009). Leaching was analyzed according to JIS K 1571 standard (JIS 1999), after the samples had first been sealed in a

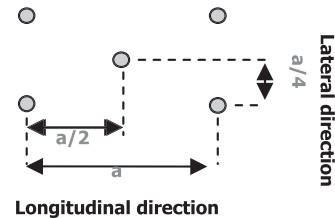


Figure 1.—Incising pattern (where $a = 20$ mm).

plastic bag and conditioned for 4 weeks at room temperature after preservative impregnation.

Results and Discussion

Penetration and retention of preservative

Preservative penetration was greater in the longitudinal direction than in the radial or tangential direction, as expected. Irrespective of the surface, the preservative penetration was higher in wood treated with the passive-impregnation method than with the full-cell method (Table 1). On the longitudinal surfaces (radial/tangential), the outer surfaces (0 and 120 mm) had higher penetration than the inner surfaces (30, 60, and 90 mm) for both methods. This might be because the preservative solution goes from the outside to the inside of wood. Similar results were reported by Islam et al. (2007, 2008, 2009) for the passive-impregnation method. The minimum penetration required by AWPA standards for refractory and thin sapwood species is typically 10 mm (AWPA 2003).

The average total preservative retention values for the passive-impregnation and the full-cell methods were 1.33 and 1.43 kg/m³, respectively. The difference in these average values was not significant.

Leaching of preservative

The full-cell treatment method resulted in significantly higher leaching percentages from the treated wood than the passive-impregnation method ($t = 6.251$, $F = 16$, $\alpha = 0.01$; Table 1). Preservative penetration and dispersion were better throughout the wood in the passive-impregnation method than in the full-cell method. The higher preservative in the outer portion of the pressure/vacuum-treated wood might be a reason for the higher level of leaching. A similar phenomenon was reported by Hingston et al. (2001), and Cooper (1994) found that higher loading in the surface increased subsequent leaching.

Conclusion

The results of this study indicate that leaching of CA-B was significantly lower in sundri wood treated using the passive-impregnation method than with the full-cell method.

Table 1.—Penetration, retention, and leaching of preservative from sundri treated by full-cell and passive-impregnation methods.

Preservation method	Cross-sectional surface	Penetration (%)					Avg. (both surfaces)	Retention (kg/m ³)	Leaching (%)
		Radial/tangential surface (mm)							
		0	30	60	90	120			
Passive-impregnation	65.7	74.1	71.4	45.9	70.2	71	66.38	1.33	0.92
Full-cell	41.9	58.2	47.4	19.4	39.9	52.7	43.25	1.43	1.18

Acknowledgment

The authors are indebted to the Japan Society for Promotion of Science (JSPS) for providing financial support.

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