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Effect of Prestain on the Treatability of Western Hemlock With Chromated Copper Arsenate

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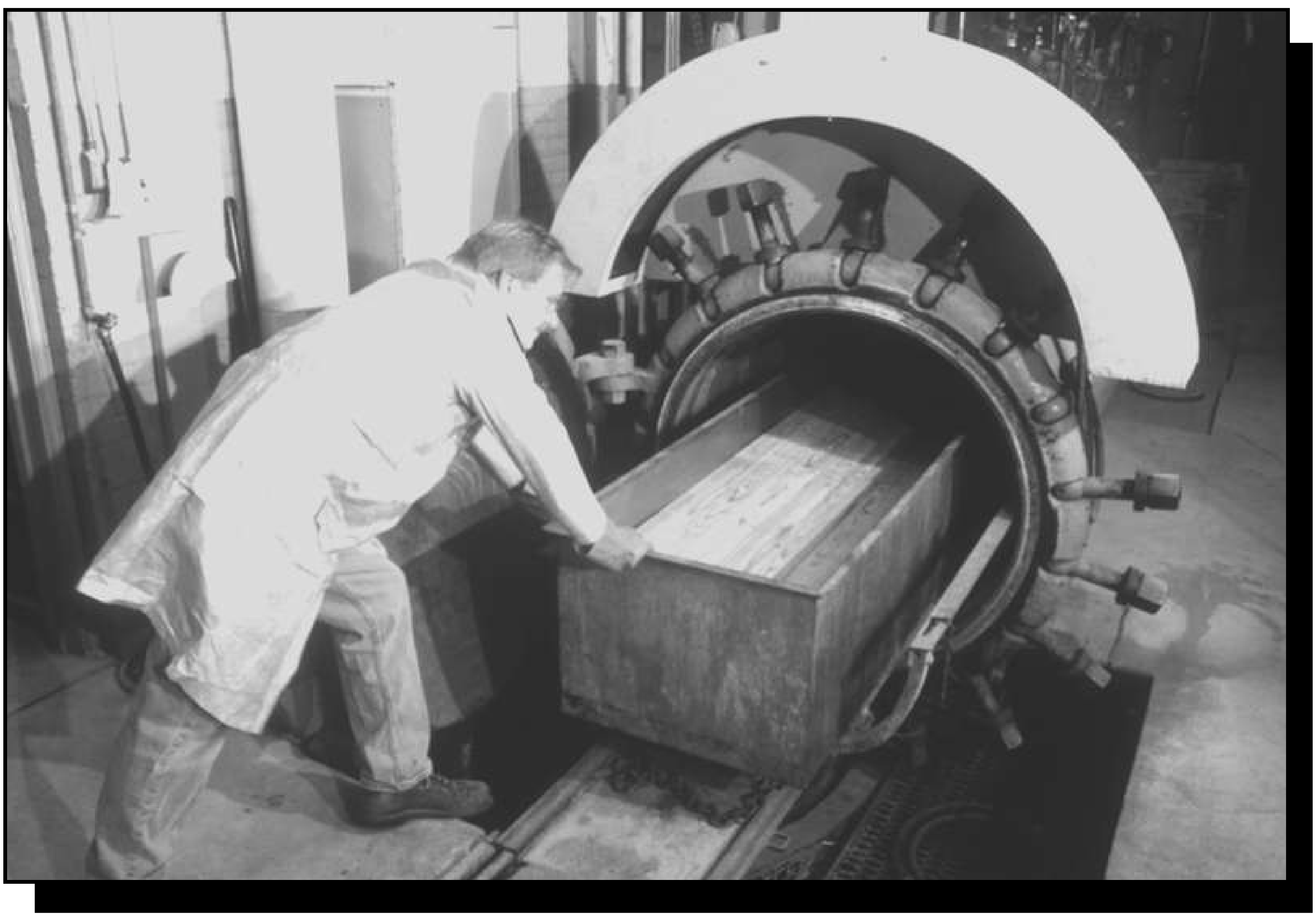

Abstract

To enhance the appearance of the treated product, a stain is often sprayed onto western hemlock lumber (*Tsuga heterophylla* (Raf.) Sarg.) prior to treatment with chromated copper arsenate (CCA-C). There is concern that this stain might interfere with the penetration and retention of CCA-C during the subsequent pressure treatment. This study compared the penetration and retention of CCA-C in prestained and nonstained end-matched specimens of western hemlock lumber. Results indicate that the weight gain retention of CCA-C solution was slightly but significantly impaired by the prestain treatment. Assayed concentration levels of copper, chromium, and arsenic detected in the treated wood were also slightly less in the prestained samples than in the nonstained samples, especially for the inner assay zone. No significant difference in average penetration was observed between the prestained and nonstained specimens, although two of the prestained specimens did have much less penetration than did their nonstained counterparts. The differences in treatability noted in this study were too small to be of concern in commercial practice.

Keywords: prestain, western hemlock, chromated copper arsenate, treatability

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Effect of Prestain on the Treatability of Western Hemlock With Chromated Copper Arsenate

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Introduction

The use of wood treated with chromated copper arsenate (CCA-C) has increased rapidly during the past two decades, primarily because of the expanded use in residential applications such as in decks (AWPI 1996). However, some consumers dislike the greenish color of the treated wood. Accordingly, CCA-C producers and wood treaters developed methods to color the wood to enhance its appearance. One method is to spray the wood with a "prestain" prior to treatment. This practice is sometimes used during production of treated Southern Pine but has become particularly common on the West Coast, where much of the CCA-C treatment is performed on western hemlock (*Tsuga heterophylla* (Raf.) Sarg.).[1]

One concern with the practice of prestaining is that it may form a coating that becomes a barrier to the subsequent penetration of CCA-C during preservative treatment. This is more of a concern with western hemlock than with Southern Pine, because western hemlock is only moderately treatable and exhibits wide variability in treatability (Cooper and Ross 1977; Kumar and Morrell 1989; Lebow and others 1996; Lebow and Morrell 1989). There is also concern that the complexation of CCA-C with the wood may be altered by the surface coating, thus increasing the leachability of the treated wood.

This paper describes a study in which the treatability of western hemlock is compared with end-matched decking specimens, prestained or nonstained. In a related paper, Lebow and Evans [in press] discuss the effect of prestaining on the rate of leaching of CCA-C components.

[1]Western hemlock is produced as part of the Hem-Fir species mix, of which it is the largest component.

Materials and Methods

Ten No. 1 Grade western hemlock boards, standard 38 by 140 mm (nominal 2 by 6 in.) and 2.4 m (8 ft) in length, were obtained from a mill in western Washington. No attempt was made to select for sapwood or a specific grain orientation. Each board was conditioned to a uniform moisture content in a room maintained at 23ºC (74ºF), then cut into five specimens. Two specimens were 610 mm (24 in.) in length, and three specimens were 406 mm (16 in.) in length. Both ends of each section were end-sealed with two coats of a neoprene rubber sealant. The longer specimens were used in an above-ground leaching study (Lebow and Evans [in press]).

The prestain applied was a commercial water-soluble acrylic polymer with an iron-oxide-based rust color. Eighteen hours prior to preservative treatment, the prestain was brushed on to one 406-mm- (16-in.-) long specimen that had been cut from each board.

The one 406-mm- (16-in.-) long specimen cut from each board that had not been prestained was weighed, pressure-treated with water using a full-cell treatment process, then re-weighed. The vacuum was maintained at –85 kPa (25 inHg) for 30 min; the pressure was maintained at 1.03 MPa (150 lb/in^2) for 2 hours. These specimens were then discarded. The uptake of water during this preliminary treatment was used to calculate the solution concentration needed to achieve a CCA-C retention of 6.4 to 9.6 kg/m^3 (0.4 to 0.6 lb/ft^3). An oxide-based CCA-C solution (active ratio of 17.4% CuO, 46.9% CrO_3, 35.7% As_2O_5) was prepared accordingly. The remaining specimens were weighed and treated in a single charge using the same treatment conditions that were used for the water treatment. Following treatment, the specimens were weighed again to determine the amount of solution uptake. Each specimen was then placed into a plastic bag and stored for 10 days at 23ºC (74ºF). The next step was to remove each specimen from the bag and sticker to air dry in a room maintained at 23ºC (74ºF) and 65% relative humidity.

Analysis of Retention

Preservative retention was determined in the outer (bark side) wide face of each piece. Assay samples were removed from the boards by drilling holes to depths of 5 mm (0.2 in.) and 15 mm (0.6 in.) from the sample surface using a 6-mm- (0.25-in.-) diameter bit. A minimum of 20 holes was drilled along the length of each specimen, and the shavings were collected for analysis. The shavings were analyzed as specified in A11-83 (AWPA 1998a). In short, the wood was dried, ground, then digested in a mixture of hydrogen peroxide and nitric acid. The resulting solution was analyzed for preservative components by atomic absorption spectroscopy.

Measurement of Penetration

One end of each specimen was cut off to allow observation of penetration in the cross section. The cut surface was sprayed with Chrome Azurol S reagent to increase the visibility of copper distribution in the wood (AWPA 1998b). The maximum and minimum penetration values were then measured on the wide and narrow faces of each specimen, and the percentage of the cross section that was treated was visually estimated.

The mean uptake retention of CCA-C solution and the mean assay retention levels of copper, chromium, and arsenic were compared for the prestained and nonstained specimens using a paired *t*-test. The minimum penetration levels in the two types of samples were also compared using a paired *t*-test.

Results and Discussion

Uptake

Application of prestain to specimens before treatment slightly, but statistically significant, reduced uptake of the treating solution (Fig. 1). The average uptake of the nonstained specimens was 6.9 kg/m^3 (0.43 lb/ft^3), and that of the prestained specimens was 6.0 kg/m^3 (0.38 lb/ft^3). The effect appeared to be the slightest in specimens with the greatest uptake, and maximized in specimens with the poorest uptake. In boards five and eight, which had the greatest uptake, the prestained boards retained more solution than did the nonstained boards. This contrasted with specimens cut from board four, in which the prestain retention was only half that of the matching nonstained specimen.

Retention

A slight reduction in assayed concentration levels of copper, chromium, and arsenic was also detected in specimens that had been prestained before treatment (Table 1, Fig. 2). The average total CCA-C retention in the 0- to 15-mm (0- to 0.6-in.) assay zone was 9.3 kg/m^3 (0.58 lb/ft^3) for the nonstained specimens and 8.3 kg/m^3 (0.52 lb/ft^3) for the prestained specimens. Although the differences appear slight, they were significant at the 90% or 95% confidence level in several cases (Table 1). The relative difference was greatest in the inner 5- to 15-mm (0.2- to 0.6-in.) assay zone.

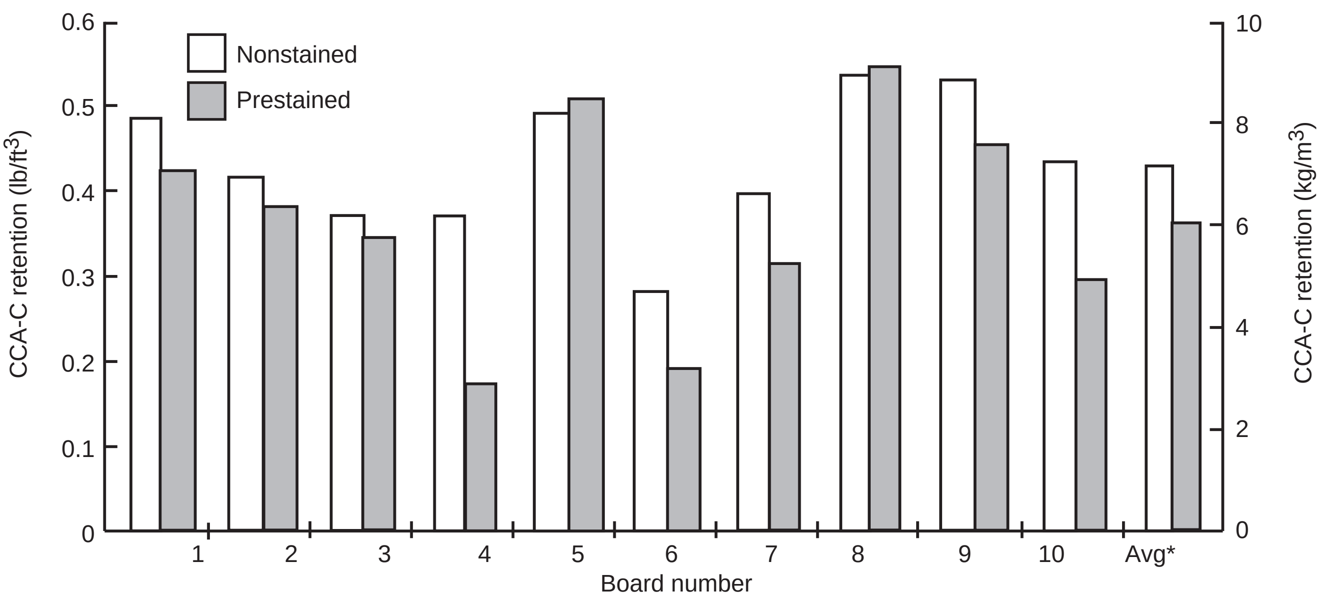

Figure 1—Uptake retention of CCA-C solution in nonstained and prestained specimens. Average uptake retention levels are significantly different at the 95% confidence level, as determined by a paired *t*-test.

Table 1—Average assay retention levels of copper, chromium, and arsenic in nonstained and prestained specimens

CCA-constituent	Average retention in each assay zone (kg/m^3 (lb/ft^3))					
	0 to 15 mm (0 to 0.6 in.)		0 to 5 mm (0 to 0.2 in.)		5 to 15 mm (0.2 to 0.6 in.)	
	Nonstained	Prestained	Nonstained	Prestained	Nonstained	Prestained
CuO	1.6 (0.10)	1.4 (0.09)[b]	2.4 (0.15)	2.2 (0.14)[a]	1.3 (0.08)	1.0 (0.06)[b]
CrO_3	4.8 (0.30)	4.3 (0.27)[b]	8.3 (0.52)	7.7 (0.48)	3.0 (0.19)	2.6 (0.16)[a]
As_2O_5	2.9 (0.18)	2.6 (0.16)[a]	5.0 (0.31)	4.6 (0.29)	1.8 (0.11)	1.6 (0.10)[b]
Total	9.3 (0.58)	8.3 (0.52)[b]	15.7 (0.98)	14.4 (0.91)	6.1 (0.38)	5.1 (0.32)[b]

[a]Significantly different from nonstained specimens at the 90% confidence level, as determined by paired *t*-test.
[b]Significantly different from nonstained specimens at the 95% confidence level, as determined by paired *t*-test.

Prestaining had a more strongly negative effect on retention in specimens cut from board four, where retention levels in the inner 5- to 15-mm (0.2- to 0.6-in.) assay zone were less than half those for the matching nonstained specimen. Prestaining also caused large retention reductions in the specimen cut from board six.

As noted for the uptake retention levels, there were two exceptions to the trend of higher loadings in the nonstained samples. In specimens cut from boards five and eight, copper and chromium retention levels in the inner 5- to 15-mm (0.2- to 0.6-in.) assay zone were greater for the prestained samples (Fig. 2a,b). Interestingly, copper and chromium retention levels in the outer 0- to 5-mm (0- to 0.2-in.) assay zone of these specimens were greater in the nonstained samples. Prestaining produced mixed effects on arsenic retention in specimens cut from these two boards (Fig. 2c).

As shown in Table 2, the prestaining did not appear to affect the proportions of chromium, copper, and arsenic that penetrated into the wood. Both the nonstained and prestained specimens contained more chromium and less arsenic than did the treating solution. Both types of specimens also contained a greater proportion of copper in the inner 5- to 15-mm (0.2- to 0.6-in.) assay zone than they did in the outer 0- to 5-mm (0- to 0.2-in.) assay zone.

Penetration

In general, penetration was good in both nonstained and prestained specimens (Table 3). Several specimens in each group were 100% penetrated. However, the pattern of penetration was erratic in some specimens, with large differences in minimum and maximum penetration on the same face.

The presence of pith in specimens cut from four of the boards appeared to have little effect on penetration.

The average minimum and maximum penetration and percentage of cross section penetrated appeared to be slightly greater for the nonstained group. However, a paired *t*-test comparison of average minimum penetrations on nonstained and prestained specimens revealed no significant difference for either the wide or narrow face. An examination of individual specimens revealed that penetration was not consistently greater in either the nonstained or prestained groups. As noted for the retention analysis, prestaining did appear to have a strong negative effect on specimens cut from boards four and six. Only 40% of the cross section on the prestained specimen cut from board four was penetrated, and 100% of the cross section was penetrated in the end-matched, nonstained specimen.

Conclusions

The use of a prestain prior to CCA-C treatment slightly, but statistically significant, lessened the retention of CCA-C components in the wood. However, the effect was generally not large enough to cause concern about the use of prestaining in commercial charges. No significant difference in penetration was detected for the prestained and nonstained specimens. Prestaining did appear to have a strong negative effect on the treatment of specimens cut from one or two of the more refractory boards. This increases the possibility that prestaining might have more of an effect when used with more refractory wood species or with the use of milder treating schedules.

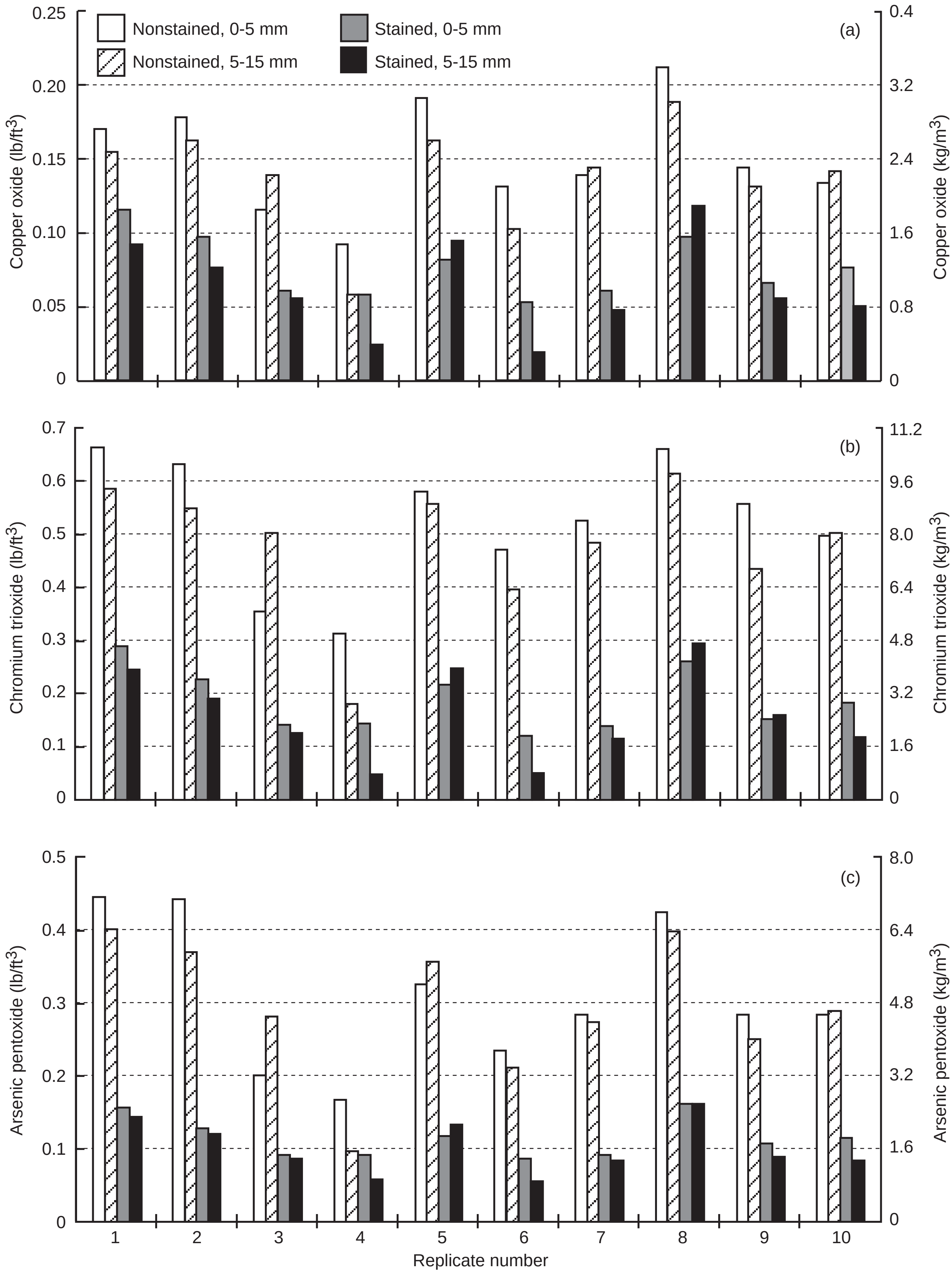

Figure 2—Assayed concentrations of (a) copper oxide, (b) chromium trioxide , and (c) arsenic pent oxide retention in the outer (0- to 5-mm) and inner (5- to 15-mm) assay zones for end-matched, nonstained and prestained specimens.

Table 2—Average ratio (percentage of 100) of copper, chromium, and arsenic retention in nonstained and prestained specimens

	Average ratio in each assay zone					
	0 to -15 mm (0 to 0.6 in.)		0 to 5 mm (0 to 0.2 in.)		5 to 15 mm (0.2 to 0.6 in.)	
CCA-constituent	Non-stained	Pre-stained	Non-stained	Pre-stained	Non-stained	Pre-stained
Copper	17.3	16.9	15.2	15.1	20.1	19.4
Chromium	51.7	51.3	53.4	52.8	49.6	49.3
Arsenic	30.9	31.8	31.4	32.1	30.3	31.3

Table 3—Penetration of CCA-C in nonstained and prestained specimens

	Penetration on wide faces (mm (in.))				Penetration on narrow faces (mm (in.))				Cross section penetrated (%)	
	Minimum		Maximum		Minimum		Maximum			
Speci-men	Non-stained	Pre-stained	Non-stained	Pre-stained	Non stained	Pre-stained	Non stained	Pre-stained	Non-stained	Pre-stained
1	6 (0.24)	6 (0.24)	19 (0.75)	19 (0.75)	32 (1.26)	32 (1.26)	70 (2.76)	70 (2.76)	95	90
2	5 (0.20)	9 (0.35)	19 (0.75)	19 (0.75)	6 (0.24)	7 (0.28)	37 (1.46)	31 (1.22)	70	70
3	12 (0.47)	19 (0.75)	19 (0.75)	19 (0.75)	49 (1.93)	70 (2.76)	61 (2.40)	70 (2.76)	95	100
4	19 (0.75)	1 (0.04)	19 (0.75)	18 (0.71)	70 (2.76)	1 (0.04)	70 (2.76)	19 (0.75)	100	40
5	5 (0.20)	19 (0.75)	19 (0.75)	19 (0.75)	9 (0.35)	70 (2.76)	40 (1.57)	70 (2.76)	70	100
6	5 (0.20)	1 (0.04)	19 (0.75)	19 (0.75)	7 (0.28)	8 (0.31)	16 (0.63)	40 (1.57)	70	45
7	4 (0.16)	5 (0.20)	19 (0.75)	19 (0.75)	16 (0.63)	3 (0.12)	35 (1.38)	35 (1.38)	80	70
8	19 (0.75)	19 (0.75)	19 (0.75)	19 (0.75)	70 (2.76)	70 (2.76)	70 (2.76)	70 (2.76)	100	100
9	19 (0.75)	7 (0.28)	19 (0.75)	19 (0.75)	70 (2.76)	35 (1.38)	70 (2.76)	70 (2.76)	100	90
10	3 (0.12)	2 (0.08)	19 (0.75)	19 (0.75)	14 (0.55)	3 (0.12)	35 (1.38)	22 (0.87)	70	85
Aver-age	10 (0.38)	9 (0.35)	19 (0.75)	19 (0.74)	34 (1.35)	30 (1.18)	50 (1.98)	50 (1.96)	85	79

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