TREATMENT OF EUCALYPT PALING FENCE TIMBERS WITH EMULSIONS OF CREOSOTE AND CCA

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ABSTRACT

Unseasoned fencing timbers of *Eucalyptus regnans* F. Muell. (mountain ash) and *E. obliqua* L'Herit. (messmate) were treated with PROCCA and PEC. Rails were treated using four different schedules. Three of the schedules, alternating pressure method (APM), presteaming plus 2 h Bethell, and 4 h Bethell, gave similar retentions of PEC in both *E. regnans* and *E. obliqua.* The remaining schedule, 2 h Bethell only, gave the lowest retentions. While presteaming increased retentions, this procedure caused greater collapse and checking than the other treatments, especially to *E. regnans*. The trend for PROCCA appeared similar to PEC. Up to 40% of the cross section of *E. regnans* rails was penetrated with PROCCA, while *E. obliqua* was more difficult to treat. Unseasoned sapwood was readily penetrated. After six months in the accelerated field simulator, untreated post ends of *E. regnans* and *E. obliqua* had 1 to 2 mm depth of decay, while all treated post ends and untreated *E. camaldulensis* Dehnh. controls were sound. Most blocks cut from PEC treated rails and palings resisted fungal colonisation in a laboratory decay test, while most blocks from PROCCA treated timbers had fungal growth on the surfaces exposed after docking.

INTRODUCTION

The traditional hardwood fence usually has posts cut from naturally durable timbers such as river red gum (*Eucalyptus camaldulensis* Dehnh.), and palings, rails and plinths cut from timbers of low natural durability such as *Eucalyptus regnans* F. Muell. (mountain ash) and *E. obliqua* L'Herit. (messmate). Because the fence is untreated, palings, rails and plinths often need replacing within fifteen years' service. Such lack of durability has been exploited by the hardwood industries' competitors, so that treated pine and steel have made large inroads into the fencing market.

The aim of this project was to produce a coloured preservative treatment that will enhance the aesthetics and durability of the hardwood fence. The project also examines whether *E. regnans* and *E. obliqua* can replace *E. camaldulensis* for fence posts. Discussions with the Timber Promotion Council indicated that the treatment would need to be applied to timbers that were unseasoned. The preservatives selected were PROCCA (Tanalith Gold) and PEC-brown, because it was thought that these oil containing preservatives would enhance weathering characteristics and reduce nail corrosion.

We expected that any treatment would produce only thin side grain penetration in the heartwood, so are examining various pre-machining options and construction practices that might extend the durability of the treated fence. One option is that

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timbers should be cut to standard lengths, and posts prenotched and profiled before treatment. The fence could then be erected in modular fashion, without the need to break the treatment envelope during construction. If alterations are necessary, some of the timber species/preservative combinations might be more able to withstand a limited amount of docking and notching after treatment. A field exposure trial, and the laboratory decay test described here, have been set up to examine the effect of machining after treatment. The in-ground portion of *E. regnans* and *E. obliqua* fence posts are likely to require additional protection to that of the above ground portions of the fence. Hence, the effects of incising and bottom end slotting of posts to improve preservative uptake are also being examined. Furthermore, a method of fixing rails to posts with fencing wire rather than by notching will be examined, and may result in the use of thinner posts. This paper presents treatment and penetration results, and an update of some of the exposure trials.

TREATMENTS AND RETENTIONS

Timber material

Eucalyptus regnans fencing components were supplied by Bonang Timbers Pty Ltd of Nowa Nowa, Vic. *E. obliqua* was supplied by Eureka Timber Company of Ballarat, Vic. The mean cross section of timbers used in the study are given in Table 1. Timber packs were stored under plastic sheeting until required.

Table 1. Timber sections used in study, and their mean moisture content prior to treatment.

Timber species	Approximate timber cross section in mm (and mean M.C.)			
	Posts	'Thin' posts	Rails	Palings
E. regnans	125 x 75 (94%)	100 x 75 (78%)	76 x 37 (101%)	100 x 20 (93%)
E. obliqua	120 x 70 (78%)	90 x 70 (80%)	75 x 35 (66%)	90-100x14 (68%)

Timbers were selected from the packs within three days before treatment. Both ends of all timber lengths were cut, and brushed with dimethyl yellow to determine sapwood/heartwood boundaries. There was less sapwood in the *E. regnans* material than the *E. obliqua* material. The dimensions of each test piece for treatment was recorded. Immediately adjacent to the test piece a block about 30 mm long was cut for moisture content (M.C.) determination (Table 1). Timbers were weighed before and after treatment to determine preservative retentions.

Some of the posts were incised before treatment. This involved sending wrapped bundles of 1.8 m long posts to the Koppers treatment plant at Grafton, NSW. After incising at Grafton, posts were again strapped, wrapped in plastic and returned to Clayton. Posts were cut into either 1.6 m, or 0.8 m lengths. Four replicates of each timber species for each preservative treatment of the 1.6 m incised posts were also prenotched, the top ends splay cut, and the bottom ends slotted before treatment. Slotting involved making three longitudinal cuts 200 mm long from the bottom end with a band saw. The slots were cut with the aim of improving preservative penetration so that a limited amount of docking could be tolerated during post installations and height adjustment.

Preservatives and treatment methods

PEC-brown contained 65% high temperature creosote and 5% brown oxide pigment. PROCCA contained 10% CCA salts and 5% oil. PEC-brown was heated to 60-75°C before treatment, while PROCCA was used at ambient temperature. Two pilot plant treatment cylinders were used. One cylinder 2.0 m long was for PROCCA treatment, while the other cylinder 2.9 m long was for PEC. Timbers were loaded into the cylinders and separated with stickers at one end near the cylinder door before treatment.

For PROCCA four different schedules were examined using 1.2 m rails (all vacuums were -90 to -100 kPa):

1. Two hour Bethell
Initial vacuum 30 mins, hydraulic pressure of 1400 kPa for 120 mins, final vacuum 30 mins.

2. Alternating pressure method (APM)
Initial vacuum for 30 mins. A pressure of 1400 kPa was then applied for 10 mins, released to atmospheric pressure for 5 mins, and then reapplied. There were 12 such pressure cycles, so that the total duration of pressure was 120 mins. Final vacuum was 30 mins.

3. Three hour steaming followed by two hour Bethell
Timber was loaded into the cylinder, and high pressure steam applied for 180 mins. The timber was then removed and allowed to cool for several hours. It was weighed, and reloaded into the cylinder for treatment. Initial vacuum was for 30 mins, 1400 kPa pressure for 120 mins, and final vacuum 30 mins.

4. Four hour Bethell
Initial vacuum 30 mins, hydraulic pressure 1400 kPa for 240 mins, final vacuum 30 mins.

For PEC the same schedules were used, except that the average pressure achieved was 1200 kPa. All remaining timbers treated with PEC-brown or PROCCA were impregnated using the four hour Bethell cycle.

Retention results

A summary of retention results are presented in Table 2. Using the 1.2 m rails, four different treatment schedules for each preservative were examined. The results were analysed using one-way ANOVA. We decided to exclude those replicates containing 30% or more sapwood from the analysis, leaving 8-10 replicates. For the PEC treatment of *E. regnans*, the 2 h Bethell schedule gave the lowest mean retention (51.7 kg/m^3). This retention was significantly lower than the mean retentions achieved for all other treatments. The 4 h Bethell schedule gave the highest mean retention (105 kg/m^3). Both the APM and the presteaming plus 2 h Bethell treatment gave similar mean retentions (74.9 and 72.9 kg/m^3 respectively). Conversely for the PEC treatment of *E. obliqua*, an analysis of variance showed that there was no significant difference between the retentions obtained using the four different treatment schedules. When results for both *E. regnans* and *E. obliqua* are combined, the 2 h Bethell was again shown to have lowest mean retention (52.0 kg/m^3). However, the mean retentions obtained with the other three schedules, APM (78.7 kg/m^3), presteaming plus 2 h Bethell (78.7 kg/m^3) and 4 h Bethell (89.6 kg/m^3), were not significantly different.

Both the PROCCA treatment of *E. regnans* and *E. obliqua* showed there was no significant difference in mean retention obtained by the four different treatment schedules. However, when both timber species are combined and compared, the mean CCA retention obtained from the 2 h Bethell (5.5 kg/m^3) was significantly different to the presteaming plus 2 h Bethell (9.1 kg/m^3), but not the APM (7.0 kg/m^3) or 4 h Bethell (7.4 kg/m^3).

Rails removed from the PEC treatment cylinder after steam conditioning showed signs of warp and collapse. At first, this effect did not occur for timbers from the PROCCA treatment cylinder. Perhaps steaming conditions in this cylinder were less harsh. However, after the PROCCA treated rails had seasoned, the presteamed timbers had greater collapse and checking than those treated using the other schedules. This difference was more obvious for *E. regnans* than *E. obliqua.*

Palings 1.2 m long treated with PEC-brown achieved mean PEC retentions of 120 kg/m^3 for *E. regnans* and 164 kg/m^3 for *E. obliqua* (Table 2). PEC contains 65% creosote, thus mean creosote retentions of 78 kg/m^3 and 107 kg/m^3 respectively were achieved. PROCCA contained 10% CCA, therefore *E. regnans* palings had a mean of 10.5 kg/m^3 CCA, and *E. obliqua* 11.8 kg/m^3 CCA. A higher proportion of sapwood in the *E. obliqua* material than the *E. regnans* material probably accounts for their higher mean preservative retentions. The above-ground H3 retention requirement for hardwoods is approximately 79 kg/m^3 for creosote and 10.4 kg/m^3 for CCA salt (AS 1604-93). While many palings met these retention requirements, few would meet the penetration requirements (see penetration results).

The surfaces of PROCCA treated timbers were touch dry soon after treatment. However, the PEC treated timber surfaces were still moderately wet with creosote oil three weeks after treatment. Treatment was performed during winter. In summer, surfaces would dry more quickly. Natural round eucalypt posts from another project were treated at a similar time as the fencing timbers, using the standard PEC white formulation (containing 3.5% white pigment). These dried more quickly than the sawn fencing timbers.

PENETRATION STUDIES

Some of the timbers have been or are in the process of being examined for preservative penetration. Some of the post sections were treated as 0.8 m lengths. After treatment, they were cut in half to produce 0.4 m specimens for a Walpeup termite field test, and the AFS exposure. Those treated with PROCCA were sprayed on the freshly cut surface with chromazurol solution (AS 1605-1974) to detect the presence of copper. Those 0.8 m specimens treated with PEC were placed in a freezer for three weeks prior to cutting, so as to reduce creosote bleeding. They were photographed within five minutes of cutting.

An examination of the penetration patterns in posts from both species showed that sapwood corners when present were penetrated by the preservatives, even though the timber was unseasoned. The side grain penetration into the heartwood of both timbers was mostly 0.5-1 mm deep, including the side grain around the incisions. However, many of the vessels in the *E. regnans* posts were treated due to end grain penetration. Deep vessel penetration was more limited in *E. obliqua.*

In order to quantify penetration in the PROCCA treated rails, we used the method described by Saunders (1982) and Ladu *et al.* (1995). This involved laying a grid of dots drawn on a transparent sheet over the end grain of specimens. The number of dots overlapping the indicated penetration patterns are then counted, and used to derive a percentage treated cross section out of the total number of dots fitting the cross section. Percentage penetrations were measured on surfaces docked 100 mm and 600 mm from the ends of the 1.2 m rails.

The penetration results for the PROCCA-treated rails (Table 3) were mostly consistent with retention results (Table 2). For *E. regnans* the penetration results show that the 2 h Bethell treatment delivered least preservative into wood. The APM, presteaming plus 2 h Bethell, and 4 h Bethell schedules produced higher penetrations, with means that were not significantly different. The presteaming plus 2 h Bethell treatment tended to produce the highest mean retentions, with about 40% of the cross section penetrated with the copper from PROCCA. As might be expected, there was also a trend where less preservative was found near the centre of the rails than near the ends. *E. obliqua* heartwood was much more difficult to treat than *E. regnans* heartwood, with means of only 1 to 8 % of the cross sections penetrated.

ACCELERATED FIELD SIMULATOR ASSESSMENT

An accelerated field simulator trial is being conducted on treated post ends. Five replicates of each post type, timber species and preservative were installed. Untreated *E. camaldulensis* post ends were included for comparison. Specimens are 400 mm long, distributed between two soil troughs, and buried 300 mm into 'Toolangi forest loam'. General details of the soil and test procedure can be found in the article by Cookson (1994). This project will provide a useful comparison of preservative treated posts in the AFS, and in field tests at both Clayton and Walpeup.

After six months in the AFS, a limited amount of decay was found in just the untreated *E. regnans* and *E. obliqua* posts (Table 4). All treated posts and the untreated *E. camaldulensis* posts were sound.

LABORATORY DECAY TEST

The laboratory decay test was designed to investigate whether palings and rails could resist decay after being docked to length. Eight replicate palings and rails of each preservative and timber species were sampled. Heartwood blocks 30 mm long were cut from the 1.2 m palings and rails. The blocks were either 'end' blocks cut 100 to 160 mm from the ends of specimens, or 'centre' blocks cut from the central 100 mm portion of the specimens. Three replicate end and centre blocks were cut from each paling or rail, with one replicate destined for exposure to either the white rot fungus *Perenniporia tephropora* (DFP 7904), the brown rot fungus *Coniophora olivacea* (DFP 1779), or to act as a sterile control. The blocks were artificially weathered, and exposed to decay fungi using procedures similar to that described by Cookson and Dougal (1993), except that the end grain of blocks was not coated with epoxy. In this method, blocks were placed in trays containing fungus (except sterile control trays) on malt agar, covered with aluminium foil and placed in plastic bags for incubation. After 16 weeks, the trays were uncovered and the level of fungal growth on each block recorded. Blocks were then removed and are now conditioning to constant mass to enable mass loss determinations.

The mass loss figures are not yet available, however, the level of fungal growth observed on each block gives an indication of performance. Tables 5 and 6 show the mean percentage fungal cover observed on the two docked faces of each block. The untreated *E. regnans* and *E. obliqua* were fully or mostly covered in fungal growth. Some noteworthy findings were that untreated *E. regnans* was heavily decayed, especially by the white rotting fungus. Untreated *E. obliqua* has little if any decay, and is moderately durable. *C. olivacea* was more sensitive to creosote than *P. tephropora*, and failed to grow on most creosote treated blocks. Creosote treated timber suffered less decay after docking than the PROCCA treated timber. This may be due to the bleeding of creosote across the docked surface of blocks when they were cut.

CONCLUSIONS

While the project is in its early stages, results so far suggest that green *E. obliqua* and *E. regnans* can be treated with either PEC or PROCCA sufficient to protect sapwood, and that treatment will provide added protection to heartwood. Treatment of rails and palings should extend service life compared to the same untreated components in the traditional hardwood fence. Early results suggest that palings and rails treated with PROCCA should be precut to final dimensions to avoid docking after treatment. PEC treated rails and palings may be able to withstand a limited amount of docking after treatment, as creosote tends to bleed across freshly cut surfaces to partially renew the antifungal barrier. The work is at a stage too early to suggest whether treated posts could replace untreated *E. camaldulensis* posts.

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REFERENCES

Australian Standard (1974). Methods for the sampling and analysis of wood preservatives and preservative-treated wood. Standards Association of Australia. No. AS 1605-1974.

Australian Standard (1993). Timber--preservative-treated--sawn and round. Standards Association of Australia. No. AS 1604-1993.

Cookson, L.J (1994). The performance of chlorothalonil after 4.5 years in the accelerated field simulator. Internat. Res. Group on Wood Pres., Document No. IRG/WP/94-30041.

Cookson, L.J. and Dougal, E.F. (1993). Decay evaluation of the penetration of LOSP into Eucalyptus regnans heartwood. 24th Forest Prod. Conf. Nov. 15-18. Topic 2/5.

Ladu, G.E., Cookson, L.J. and Dougal, E.F. (1995). Treatability of regrowth *Eucalyptus regnans* heartwood using light organic solvent. Wood Protection 3: 33-39.

Saunders, L.D.A. (1982). Some insights into the behaviour of organic solvent preservatives during the impregnation of European whitewood. Rec. Ann. Conv. BWPA 1982, pp. 46-53.

Table 2. Summary of retention results in kg/m^3, based on total volume of piece. Showing mean (and standard deviation). PEC retentions are for whole PEC, and PROCCA retentions are for CCA salt.

Treatment schedule	Profile, length	No. of replic.	PEC		PROCCA	
			E. regnans	*E. obliqua*	*E. regnans*	*E. obliqua*
2h Bethell	Rail, 1.2m	9-10	51.7 (17.2)	52.2 (15.2)	5.5 (1.4)	5.4 (2.7)
APM	Rail, 1.2m	8-10	74.9 (29.2)	82.9 (40.5)	8.6 (35)	5.1 (3.0)
Steam + 2h Bethell	Rail, 1.2m	9-10	72.9 (18.0)	84.5 (16.3)	10.1 (4.3)	8.1 (4.2)
4h Bethell	Rail, 1.2m	10	105.0 (25.3)	74.2 (43.0)	8.8 (5.2)	6.0 (2.6)
"	Rail, 1.6m	3	60.9 (14.2)	58.3 (34.7)	6.6 (1.8)	6.1 (4.5)
"	Plinth1.6m	1	86.6	95.0	6.3	9.7
"	Thin post, 1.6m. I,S	4	95.2 (24.8)	50.9 (4.9)	13.1 (0.7)	5.0 (0.3)
"	Post, 1.6m I	4	87.5 (31.0)	65.4 (9.1)	10.2 (1.3)	5.1 (1.3)
"	Post, 1.6m I,S,N	4	72.3 (20.4)	104.2 (21.4)	8.7 (3.3)	6.0 (2.3)
"	Post, 1.6m plain	4	-	-	11.1 (3.9)	2.8 (0.4)
"	Post, 0.8m I	8	92.0 (19.7)	57.7 (28.7)	8.7 (3.7)	5.6 (1.4)
"	Post, 0.8m I,S	8	130.9 (28.2)	98.7 (10.0)	9.8 (3.7)	6.6 (2.0)
"	Post, 0.8m plain	5	59.8 (25.3)	53.5 (17.1)	5.3 (1.9)	3.1 (0.7)
"	Paling, 1.3m	12	108.9 (29.6)	96.1 (33.0)	11.1 (2.7)	10.0 (5.7)
"	Paling, 1.2m	36-44	120.2 (38.9)	163.5 (58.5)	10.5 (2.9)	11.8 (7.0)

For posts, I = incised, S = end cut slots at one end (1.6 m posts) or both ends (0.8 m posts), N = prenotched for rails to be fitted.

Table 3. Penetration in PROCCA-treated 1.2 m rails. The percentage of a cross section (100 mm and 600 mm from ends) with positive indication for copper. Mean (standard deviation) of eight replicates.

Timber species	**Distance from end**	**Percentage cross section with indication of copper**			
		2 h Bethell	**APM**	**Steaming + 2 h Bethell**	**4 h Bethell**
E. regnans	100 mm	13.3 (11.7)	32.2 (23.7)	41.8 (26.6)	30.0 (29.3)
E. regnans	600 mm	8.2 (6.0)	26.9 (22.7)	39.8 (22.7)	21.8 (27.3)
E. obliqua	100 mm	3.7 (5.8)	3.3 (7.5)	7.6 (8.8)	6.6 (8.6)
E. obliqua	600 mm	1.5 (2.3)	1.7 (3.2)	4.4 (7.1)	1.4 (3.8)

Table 4. Depth of decay found in 400 mm long post ends after six months exposure in the AFS.

Timber species	Treatment	Depth of soft rot after 6 months		
		Plain	**Incised**	**Incised + slotted**
E. regnans	None	2 mm	-	-
E. regnans	PROCCA	0 mm	0 mm	0 mm
E. regnans	PEC	0 mm	0 mm	0 mm
E. obliqua	None	1 mm	-	-
E. obliqua	PROCCA	0 mm	0 mm	0 mm
E. obliqua	PEC	0 mm	0 mm	0 mm
E. camaldulensis	None	0 mm	-	-

- not in test.

Table 5. Percentage of surface on cut end grain faces of paling blocks covered by fungus. Mean (standard deviation) of 16 faces on eight blocks.

Fungus	Preservative	Position	*E. regnans*	*E. obliqua*
Brown rot *C. olivacea*	None	Any	91 (25)	81 (35)
	PROCCA	End	89 (22)	64 (42)
		Centre	68 (34)	87 (29)
	PEC	End	0 (0)	0 (1)
		Centre	1 (2)	1 (2)
White rot *P. tephropora*	None	Any	100 (0)	100 (0)
	PROCCA	End	97 (4)	96 (8)
		Centre	96 (5)	100 (1)
	PEC	End	16 (24)	33 (36)
		Centre	31 (30)	40 (38)

Table 6. Percentage of surface on cut end grain faces of rail blocks covered by fungus. Mean (standard deviation) of 16 faces on eight blocks.

Fungus	Preservative	Position	*E. regnans*	*E. obliqua*
Brown rot *C. olivacea*	None	Any	90 (17)	82 (14)
	PROCCA	End	64 (34)	48 (37)
		Centre	47 (33)	60 (37)
	PEC	End	0 (0)	0 (0)
		Centre	0 (0)	0 (0)
White rot *P. tephropora*	None	Any	93 (25)	65 (34)
	PROCCA	End	81 (13)	71 (23)
		Centre	81 (29)	69 (23)
	PEC	End	1 (3)	0 (1)
		Centre	20 (29)	1 (3)

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