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Section 4 Processes

TRANSMISSION POLES WITH SUB-STANDARD CREOSOTE RETENTIONS PROTECTED BY FIELD LINERS OUTPERFORM STANDARD POLES IN SERVICE

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SUMMARY

Eucalyptus cloeziana 12m transmission poles were treated with sub-standard creosote retentions of 80kg.m^{-3} and Field Liners were fitted to the poles before they were placed in service at Umbumbulu, Kwazulu Natal. Poles treated with standard creosote retentions of 130kg.m^{-3} but without Field Liners were also placed in service in the same area. Core samples were taken from both groups of poles after 12 month's service and these were analysed for creosote content. It was found that the creosote retentions in the outer 10mm of the sub-standard poles fitted with Field Liners had increased to mean values of 212.76kg.m^{-3} and 219.24 kg.m^{-3} at depths of 100mm and 500mm respectively below the groundline. In contrast, the creosote contents of the standard poles without Field Liners had decreased to mean values of 49.20 kg.m^{-3} and 52.64 kg.m^{-3} at depths of 100mm and 500mm respectively below the groundline. It was also seen that the creosote had migrated under gravity from the tops to the groundlines of the poles. The difference in creosote retentions below the groundlines arose because the mobile creosote migrated out of the poles without Field Liners by leaching into the surrounding soil, whereas such mobility was physically arrested when creosote was confined to the wood in the subsoil sections of poles fitted with Field Liners.

KEY WORDS: Transmission poles; creosote migration; Field Liners

INTRODUCTION

Many factors seem to contribute to the overall process of premature pole failure. Hurdle theory has been used (Baecker 1993a) to explain how physical barriers affect growth factors to prevent fungal colonisation and decay of untreated wooden poles in soil when applied as Field Liners (FL's) to their soil-contact surfaces. Since nitrogen is a limiting essential macronutrient in fungal decay of wood, hurdle theory also predicted that untreated poles would be protected because the Field Liners would prevent hyphal translocation of supplementary nitrogen from soil to such wood. This prediction was proven correct (Baecker 1993b) when untreated poles which had been in soil contact for six months without Field Liners were decayed to failure below the groundline while lined poles remained intact.

Replicate lined poles did not fail even after two years' service and, although Field Liners were not originally designed for protection of untreated poles, a niche exists for some consumers who require poles to serve only for two to four years and do not wish to use conventional chemical preservatives for economic or environmental reasons. Bioplast™, a novel Field Liner material which prevents spore germination at the wood-liner interface on poles in service was developed for this purpose (Baecker and Behr, 1995).

When applied to treated poles, Field Liners constitute a primary treatment which can influence not only premature failure of such poles but also the risk of environmental pollution. For example it was found in our earlier work that Field Liners prevented significant leaching of creosote from treated vineyard poles under flood irrigation (Behr and Baecker, 1994), while unlined treated poles which lost creosote in the moist soil, began to decay. We therefore concluded that at least two of the factors which contributed to premature failure of these vineyard poles were

(a) creosote loss from the wood, followed by
(b) fungal attack of such detoxified wood.

It followed from the above conclusions that, while Field Liners constituted an important method to prevent premature failure of treated poles in soil, these biotechnological devices may also play a significant role in the prevention of soil pollution arising from preservatives leached from poles in service. The electrical supply grid is currently being extended in South Africa as part of a national reconstruction and development program. The scope of our studies was therefore expanded to encompass Field Liners used to protect larger-dimensioned electrical distribution and transmission poles. It was subsequently shown that (i) the principle of vineyard pole protection by Field Liners could also be applied to much larger transmission poles, and that (ii) this principle could be applied only after Field Liner materials with improved durability and practicable application and insertion equipment had been developed and tested (Behr, Shelver and Baecker, 1996).

The present work was conducted to examine the performance of the above transmission poles after one years's service.

MATERIAL AND METHODS

Application. Three hundred 12m *E. Cloeziana* transmission poles were treated according to SABS 754 (South African Bureau of Standards, 1994) but owing to their narrow sapwood dimensions only 11mm creosote penetration and less than 80kg.m^{-3} creosote retention was obtained in these poles. The authors have developed Field Liners suitable for many different pole service conditions (Shelver, Behr and Baecker, 1995) and in the course of that work it had been found that polypropylene was not plasticised by creosote (Behr, Shelver and Baecker, 1996). A co-axially extruded bilayer of polypropylene-LDPE film 120um thick was therefore used, with the polypropylene layer innermost, to produce 300 Field Liners 2.0m long with layflat dimensions ranging between 370 - 470mm. An infra-red heat source was used to shrink one such Field Liner onto each pole as an inner liner. A second Field Liner of either cross-linked linear low density polyethylene (LLDPE) 240um thick incorporating the termiticide deltamethrin, or alternatively, of LDPE 500um thick, was then shrunk over the inner Field Liners to provide an outer layer incorporating termite resistance and/or abrasion resistance during transport and installation.

The poles were transported 350km by road to Umbumbulu, Southern Kwazulu-Natal and restacked where an electrical distribution network was being installed. All poles were then transported to excavated holes and manually installed as normal.

A second series of normal *Eucalyptus* transmission poles were also installed at the same time at Umbumbulu and these were also treated with creosote, but to the full specification of SABS 754 (South African Bureau of Standards, 1994) of 100kg.m-3. These poles did not have Field Liners applied.

Assessment. The poles with and without Field Liners were inspected after 12 months service. It was found that the full specification poles without Field Liners had leached creosote which was visible in the surrounding soil (Fig. 1), and which had inhibited growth of vegetation around the poles. In marked contrast, the poles with Field Liners were surrounded with plant growth and no creosote could be detected in the soil around these poles.

Three poles without Field Liners and three poles with Field Liners were excavated to a depth of 750mm. An increment borer was used to take core samples from each pole 500mm above the ground line and from 100mm and 500mm below the ground line. Windows were cut in the Field Liners where neccessary. The boreholes were plugged with creosoted dowels, the windows were closed and sealed and all excavations were backfilled.

The outer 10mm of each sample was then analysed for creosote content (American Wood Preservers ' Association, 1976).

RESULTS AND DISCUSSION

It is worthy of note that, when windows were cut to take samples from below the groundlines of the sub-standard poles with Field Liners, a thin layer of creosote found between the wood surface and the interior of the Field Liner in each case marked the hands of the authors. In contrast, the equivalent surfaces of standard poles without Field Liners did not leave creosote deposits on the hands of the authors, presumably because it was already in the soil (c.f. , Fig. 1). The cresosote analyses of core samples was converted to retentions as listed in Table 1. and the mean values of these retentions are illustrated in Fig. 3.

The quantitative evidence presented here strikingly confirmed points previously made by these authors (Behr and Baecker, 1994), viz., creosote could literally be seen leaking from creosote-treated poles to the soil (Behr, Shelver and Baecker, 1996), thus causing environmental pollution. However, the quantitative results also confirmed unequivocally the principle that Field Liners, when applied as a primary treatment on creosote-treated transmission poles, prevent pollution attributable to creosote loss from the ground contact regions of the poles.

Fig. 1. Ground line of standard transmission pole (treated with 100kg.m^{-3} creosote by the full cell process) after 12 months' service . Bleeding creosote is visible running down the surface of the pole and the soil surrounding the pole is visibly polluted with the leached creosote. Note lack of vegetation in bare polluted zone of poisoned soil.

Fig. 2. Ground line of sub-standard transmission pole (treated with 80kg.m^{-3} creosote by the full cell process) after 12 months' service. No creosote was visible running down the sides of such poles, nor was the soil surrounding them polluted by creosote. In keeping with these observations, no bare soil existed and vegetation completely surrounded the poles.

Table 1. Creosote contents* of sub-standard transmission poles with Field Liners and standard poles without Field Liners after 12 months' service with verified creosote retentions of 80kg.m^{-3} while the standard poles began with verified retentions of 100kg.m^{-3}

Position of core in pole	Sub-standard Pole with Field Liner			Standard Pole without Field Liner		
	1	2	3	4	5	6
500mm below ground line	15.26 (91.56)	16.66 (99.96)	17.15 (102.90)	23.04 (138.24)	23.66 (141.96)	16.53 (99.18)
	(mean = 98.14)			(mean = 126.46)		
100mm below ground line	27.96 (167.76)	36.91 (221.46)	41.51 (249.06)	14.17 (85.02)	6.88 (41.28)	3.55 (21.30)
	(mean = 212.76)			(mean = 49.20)		
500mm above ground line	26.60 (159.60)	42.44 (254.48)	40.58 (243.48)	15.79 (94.74)	8.40 (50.40)	2.13 (12.78)
	(mean =219.24)			(mean = 52.64)		

*values are espressed as % mass/mass, while the figures in parentheses are these values converted to retentions in units of kg.m^{-3} assuming the density of *Eucalyptus* to be 600kg.m^{-3}.

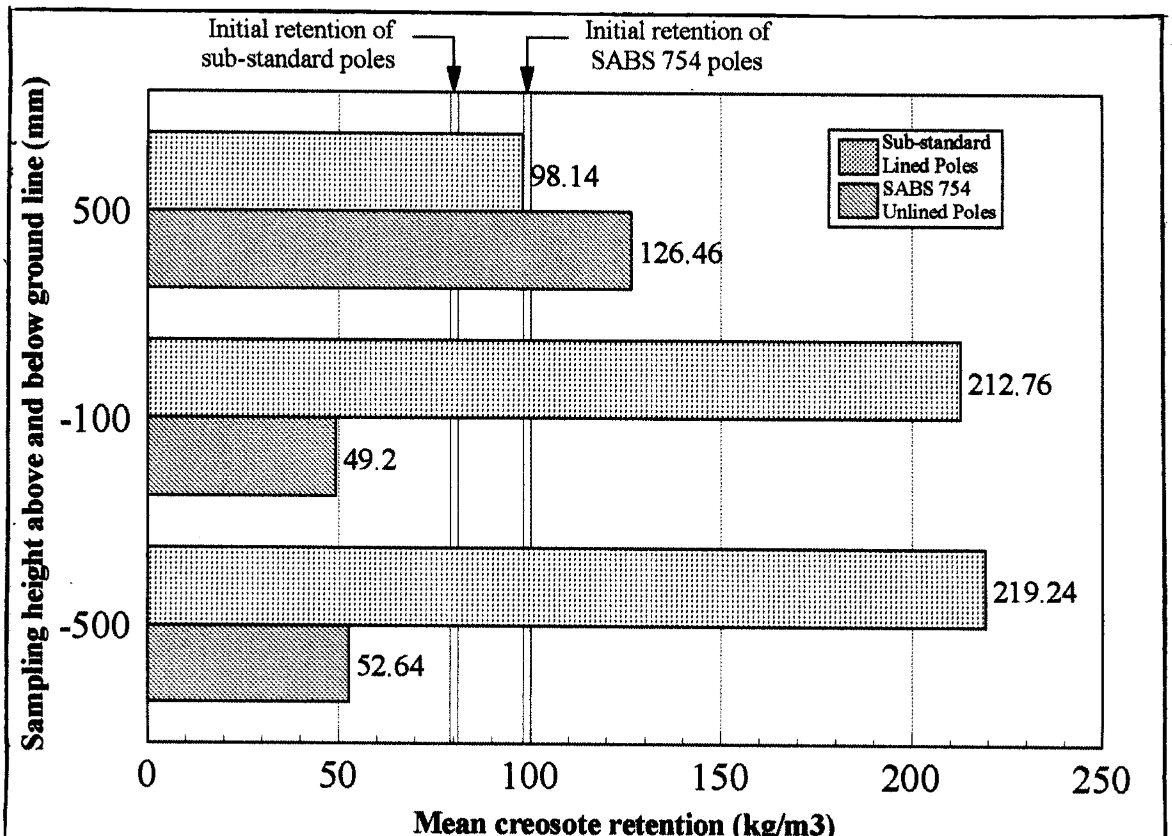

Fig. 3. Mean creosote retentions in profiles of sub-standard transmission poles with Field Liners and standard poles without Field Liners after 12 months' service in ground contact.

The principal of transmission poles being conserved by Field Liners is now proven and the technology for rapidly fitting Liners onto large poles has recently been fully developed. Importantly, the benefit of Field Liners in creosote conservation has now been quantified for transmission poles, and the large-scale trial described here can be monitored annually well into the next century.

The present findings motivate further work with Field Liners applied to poles treated by the empty cell process, since (i) Field Liners would undoubtedly render such poles adequately protected in soil, (ii) cost savings against poles treated by the full cell process would compensate for the Field Liner costs, and (iii) less creosote would be placed into the environment.

The empty cell treatment process is not used for transmission and distribution poles in South Africa. Our current work to test Field Liner performance on creosoted poles with lower retentions applied by the empty cell process, and on poles treated with a variety of other preservatives, is therefore being carried out as a CRAFT Project under the auspices of the European Community.

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