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Effect Of Oil Content On The Performance Of Wood Treated With Pentachlorophenol

by

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Effect Of Oil Content On The Performance Of Wood Treated With Pentachlorophenol[1]

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ABSTRACT

This paper details a five-year study on southern pine treated with pentachlorophenol in oil at various oil contents. Results from field stake tests at two Gulf Coast test sites are presented. Both biological efficacy and preservative depletion data are discussed. Results suggest that increasing oil content leads to better performance of wood treated with pentachlorophenol. Test results indicate that the test site is extremely important when evaluating systems and that sites with high calcium and alkalinity lead to greater depletion of pentachlorophenol from wood.

Keywords: pentachlorophenol, stake tests, oil content, decay

INTRODUCTION

Pentachlorophenol (penta) primarily has been used to treat poles in the US since the 1930s. The importance and impact of the petroleum carrier on performance has been well documented in the literature (Arsenault 1976, Arsenault *et al*. 1984, Baechler & Roth 1962, Nicholas 1988, Nicholas *et al*. 1994, Walters & Arsenault 1971). In the most recent study, Nicholas *et al*. (1994) showed that performance was related to the aromatic content of the carrier oil and that systems utilizing co-solvents in #2 fuel oil gave slightly higher depletion rates and slightly lower performance.

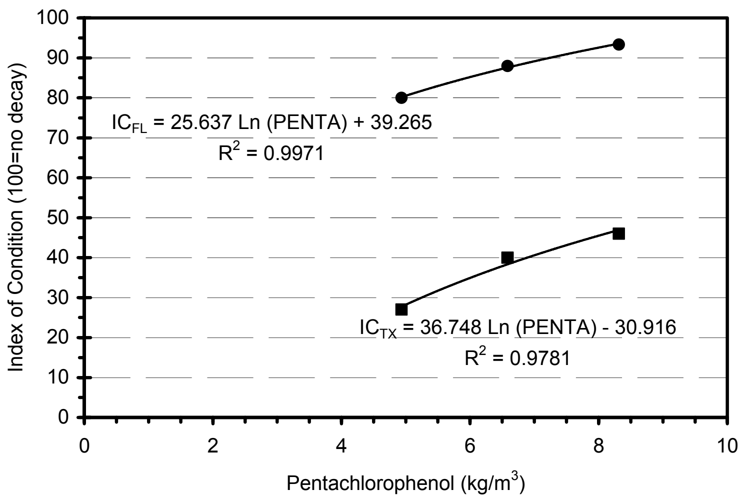

Figure 1. Dose-response curves for matched stakes treated with pentachlorophenol after five years of exposure in Galveston (TX) and Gainesville (FL).

The use of penta has come under scrutiny in recent years, especially in coastal areas. Primarily because of some bad experiences and early failures with Cellon®-treated (penta in LP gas) poles, several coastal utilities have removed penta from their specifications. Stake data from matched stakes in a test site on the Texas Gulf Coast is compared with that from a Florida test site in Figure 1. As shown, the severity of the Texas site is clear.

This research was undertaken to document the performance of penta in these regions and to ascertain the impact of oil content on the performance of pentachlorophenol.

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METHODS AND MATERIALS

Stake tests were conducted in accordance with AWPA (2002) Standard E-7. Pentachlorophenol (penta) treating solutions were prepared by dissolving a penta concentrate in an AWPA Standard P9 type A solvent. Solution strength was adjusted with toluene such that the desired penta retention (up to 9.6 kg/m^3) and the target oil content of 64, 96, 128, and 160 kg/m^3 were attained. Treatment was by a conventional Bethell (full-cell) process. The P9 type A solvent was a blend of #2 fuel oil (90%) and a still bottom ketone cosolvent (KB3, 10%). Sapwood southern pine (*Pinus* spp.) stakes measuring 1119-mm in length and 19- x 19-mm in cross section were cut into 559-mm matched halves prior to treatment. After treatment, each stake was cut to 458 mm and the remaining remnant retained for reference. One matched replicate was placed in our Harrison Forest (HF) test plot near Saucier, MS on the Gulf Coast. The other matched half was placed in the Stewart Substation test plot maintained by Reliant Energy-HL & P on Galveston Island, Galveston, TX. Twenty replicates per combination of oil content, retention, and test plot were treated and installed. Ten of these replicates were used as depletion stakes. Two stakes per combination were removed annually and assayed. Samples taken from each stake at the groundline and above-ground were sectioned into the outer 8.5 mm and remaining core and analyzed using x-ray spectroscopy. Material from like zones and locations were combined for analysis. Comparison was with similar zonal analysis of the retained sample remnants described above.

RESULTS & DISCUSSION

Efficacy tests

Dose-response curves by year at the Harrison Forest and Galveston Island test plots are shown in Figure 2 for four nominal oil contents. Yearly dose-response curves were fitted to a logarithmic function prior to graphing. These data clearly show the positive effects of increasing oil content on the efficacy of penta in oil systems.

A comparison of the effect of oil content on the performance may be seen more clearly with the fifth year data plotted in Figure 3. A comparison between the two test plots shows that the Galveston site is much more severe for decay than is the Harrison Forest site. The impact of oil content is more critical for the Galveston plot than for the Harrison Forest plot. At the HF plot, the improvement in performance for five years of exposure (Figure 3) tends to be flat at pentachlorophenol retentions above 3 kg/m^3. For the Galveston plot, increases in performance with increasing oil content are shown across all pentachlorophenol retentions with the effect lessening at the higher pentachlorophenol retentions.

Both coastal test sites are located in AWPA (2002) Hazard Zone 5, the most severe zone. The major differences are that the Galveston site is less that a half mile from the coast and is subject to inundation by sea water. Additionally, the Galveston site is surrounded by sea shells used in the road beds and on the site adjacent to the test plot. In contrast, the HF site is approximately 20 miles from the Gulf coast and has a sandy loam soil not subject to salt water incursion. The alkaline soil at the Galveston site has a high calcium content. It is postulated that because of this, pentachlorophenol in wood will convert to salt form either as calcium or sodium pentachlorophenate. These salts are highly leachable and should result in higher depletion rates from the treated stakes which should result in poorer performance in the Galveston plot.

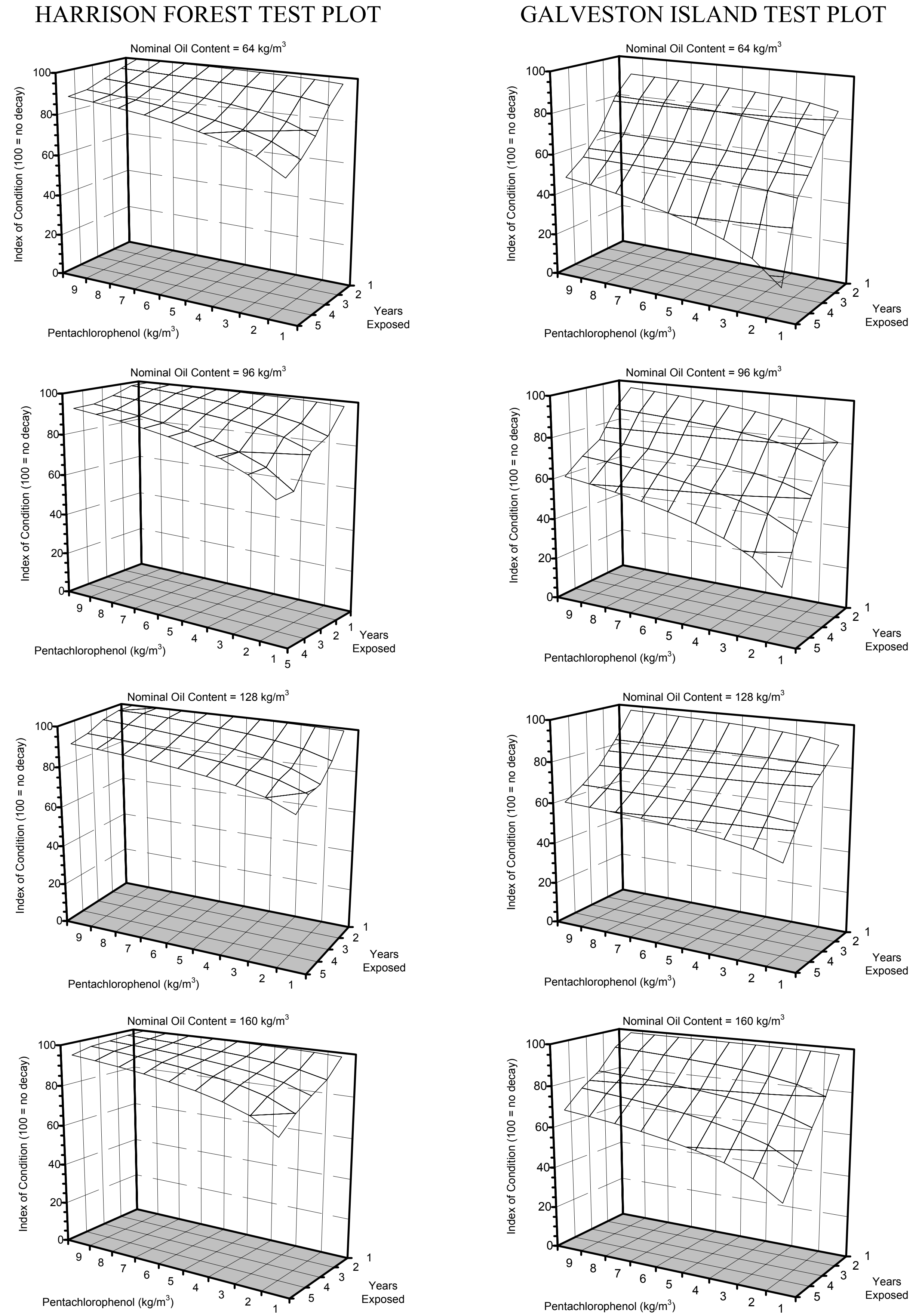

Figure 2. Dose-response curves by year at four nominal oil contents for stakes treated with pentachlorophenol in AWPA P9 type A solvent and exposed at the Harrison Forest (left) and Galveston (right) test sites.

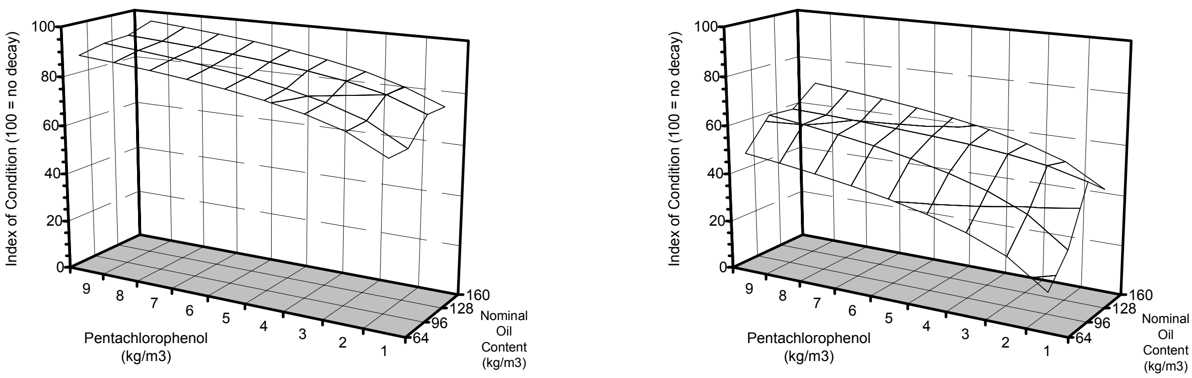

Figure 3. Effect of oil content on the performance of penta in P9A oil after five years of exposure in the Harrison Forest (left) and Galveston Island (right) test plots.

<u>Depletion tests</u>

For ease of comparison, zonal assay data were combined to yield the weighted average preservative loss from the stake cross-sections. There was no consistent trend of preservative loss *vs*. initial pentachlorophenol retention either at the groundline or above-ground for any oil content. Figure 4 is indicative of the data scatter. For this reason, data for all retentions for a given oil content were combined for presentation.

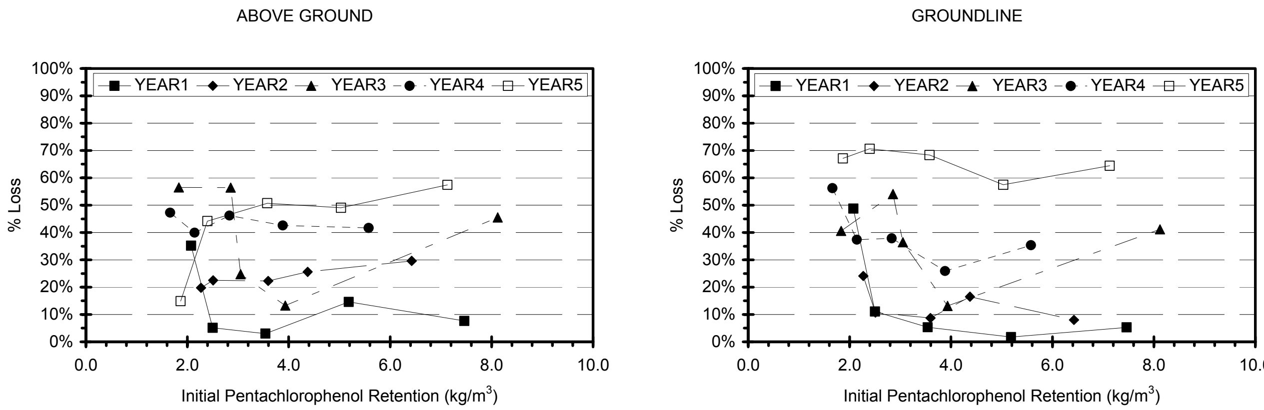

Figure 4. An example of the data scatter by year for above-ground and groundline preservative loss *vs*. initial preservative retention for the 160 kg/m^3 oil content stakes in the Harrison Forest test plot.

Data for loss of preservative at the groundline and above-ground are shown in Figure 5 for the two test plots. Depletion above-ground varies only slightly with nominal oil content in both test plots. Comparable rates are shown for both plots. This is expected since depletion above-ground reasonably can be expected to be a function of the vapor pressure of pentachlorophenol and the movement downward by gravity. Soil conditions would not be expected to impact the above-ground movement. Depletion rate increases gradually with exposure time. In the HF plot, % loss decreases with increasing oil content and tends to flatten out over time. Depletion rates over time

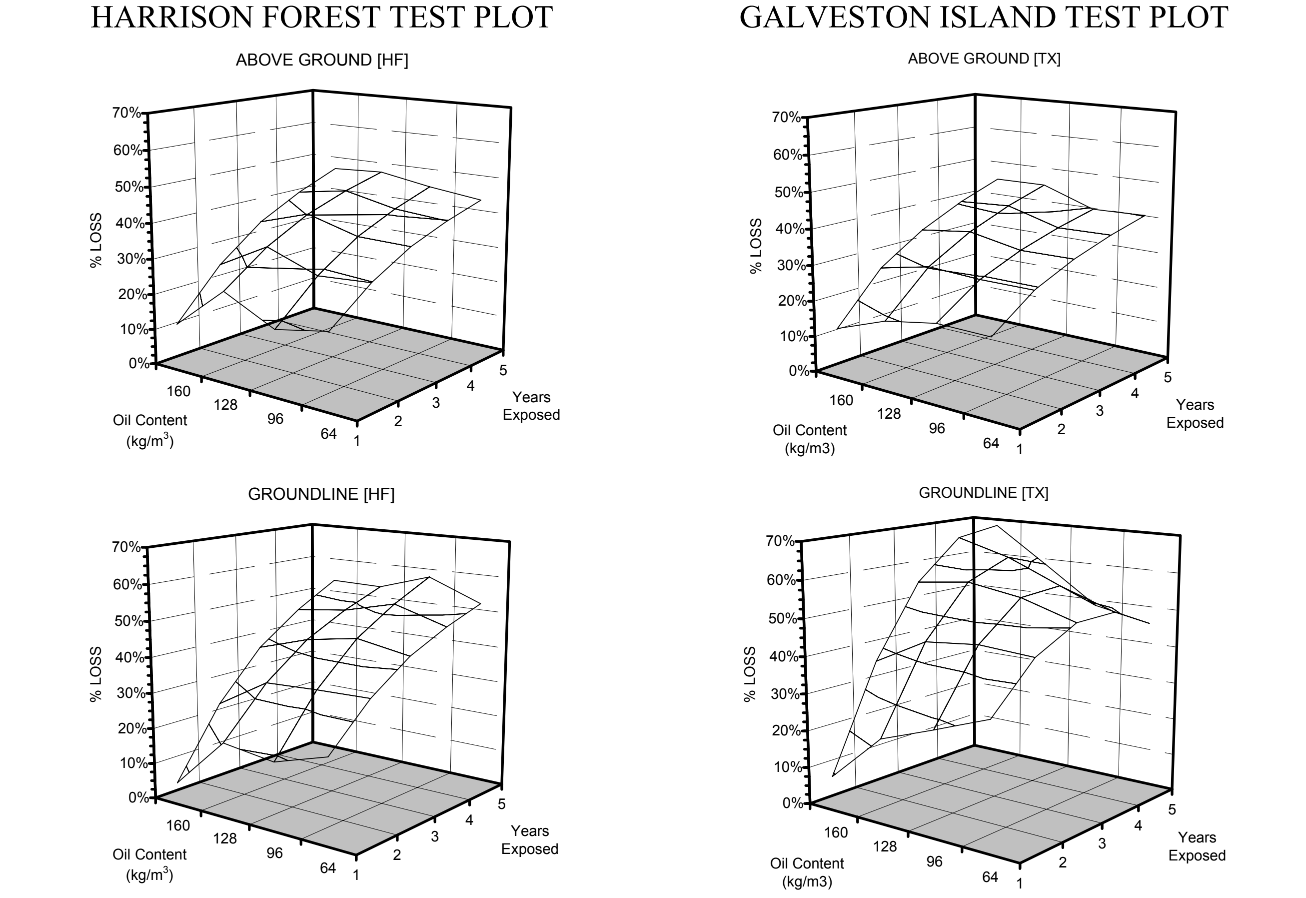

Figure 5. Preservative depletion at the groundline and above-ground as a function of oil content and exposure period for pentachlorophenol-treated stakes in two Gulf Coast test sites.

show no consistent trend with oil content, and rates tend to be equal for all oil contents as can be seen in Figure 6. An almost identical trend was noted for the above-ground location in the Galveston plot as is shown in Figures 5 and 6. The above-ground depletion rate in the TX site averaged 97% of that for the HF site over the five years of the study.

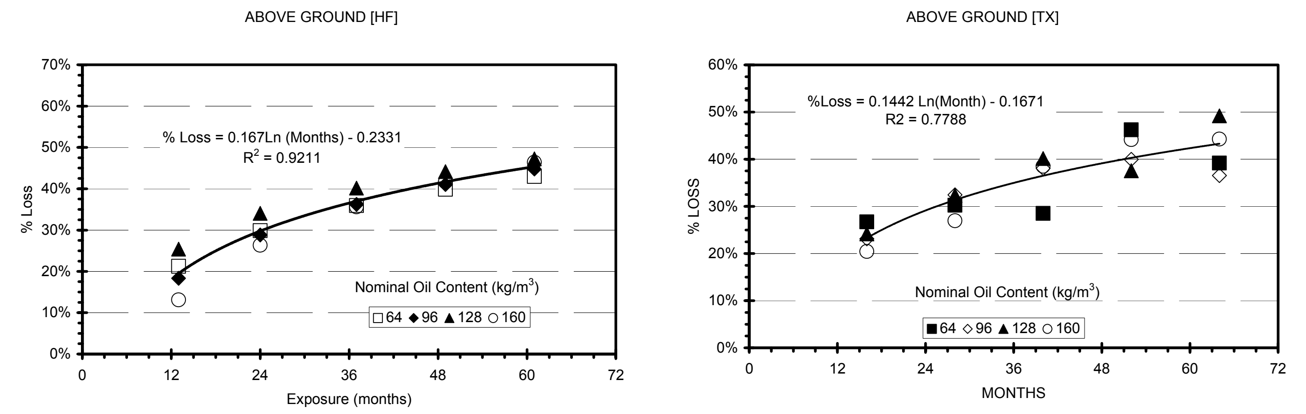

Figure 6. Depletion rates by oil content for the above-ground zone in two test plots.

Different results were obtained for the groundline location. Groundline depletion tended to be more severe than above-ground loss in the HF plot. Aside from the 160 kg/m^3 oil content, there was little to separate the different oil contents. For the first three years, the 160 kg/m^3 oil content stakes showed a lower depletion rate than the other oil contents (Figure 7) in the HF test plot. In the Galveston plot, the depletion rate was higher than in the HF plot and tended to reach a maximum in the fourth year of exposure (see Figure 7). The reason for this maximum is unclear and will require additional study. In this plot the % loss actually decreased with oil content for the first two years of exposure, leveled off in year 3 and increased with increasing oil content in years 4 and 5.

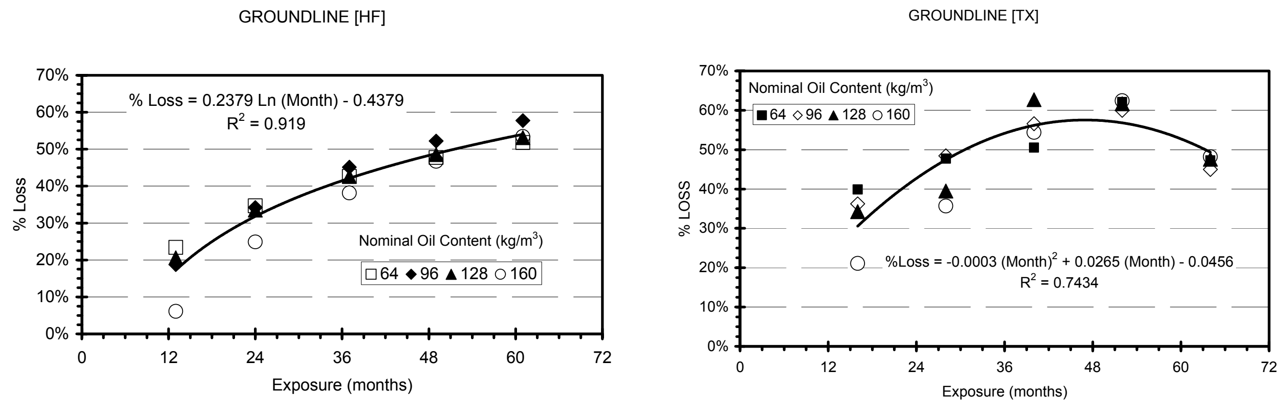

Figure 7. Depletion rates by oil content for the groundline zone in two test plots.

These data would indicate that oil content had at best a variable effect on depletion at the groundline and on the average was not well correlated with preservative depletion at the TX site. Groundline depletion rate over the five years of this study for the TX site was 21% higher than the rate found with stakes in the HF plot. These data would lend credence to the hypothesis that exposure in the TX site led to higher depletion rates and hence poor performance.

SUMMARY & CONCLUSIONS

These data suggest that increasing oil content has a positive effect on the biological efficacy of wood treated with pentachlorophenol, but other factors such as soil chemistry may have more impact on performance. Alkaline conditions, higher calcium contents, and seawater inundation found in a Texas coastal site led to higher depletion rates and hence poorer performance than in an inland coastal Mississippi site.

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