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A Comparison of Wood Preservatives in Posts in Southern Mississippi: Results from A Half-Decade of Testing

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Abstract: Wood preservatives extend the useful service life of all wooden commodities used above ground and in ground contact. Over 50 years ago, the USDA-Forest Products Lab established tests in a high decay and high termite hazard zone in southern Mississippi. During the last five decades, periodic reports have been issued by researchers located at the USDA-FPL, in Madison, WI, on the efficacy and performance of southern pine fence posts treated with a variety of wood preservatives. Since 1977, no report has been issued by the USDA-FPL on the performance of these various preservatives in southern pine posts. This study was undertaken to evaluate the long-term efficacy of over 50 wood preservatives in southern pine wood in ground contact.

This study reassessed the condition of the treated wood posts in southern Mississippi, and statistically calculated the new expected post life span. It was determined that commercial wood preservatives, like pentachlorophenol in oil, creosote, and copper naphthenate in oil, provided excellent protection for posts, with life spans now calculated to exceed 60 years. Surprisingly, creosote and penta treated posts at 75% of the recommended AWPA retention, and Copper Naphthenate at 50% of the required AWPA retention, gave excellent performance in this AWPA Hazard Zone 5 site. Untreated southern pine posts lasted 2 years in this test site.

Keywords: preservatives, posts, efficacy, performance, life span

Introduction: The objective of the original study was to evaluate the efficacy and performance of over 100 wood preservatives and wood preservative systems in southern pine posts in a severe hazard site. The test site, in southern Mississippi in AWPA Hazard Zone 5 contains severe decay potential and severe termite exposure. The purpose of this evaluation was to evaluate the performance of the 50 remaining wood preservatives in test, and update the average service life expectancy data from the previously issued report, USDA FPL-01, from 1977.

Materials and Methods

Southern Pine posts (SYP), with an average 4-5 inches in diameter, were air dried, and then were treated with a variety of over 100 different preservative systems by Rueping or Lowry processes for the oil-borne or oil-type systems, or full cell for the water borne systems at the United States Dept. of Agriculture facility in Madison, WI. These resultant treated posts were shipped to the MSP test plot located in Harrison, MS and planted approximately one-third of their length in the soil.

After 53 years of exposure in southern Mississippi, posts were stressed to a possible failure point by the use of a 50 lb. (22.73 Kgm) pull test (see example photo in Figure 3). Many of the posts failed upon

exposure to the stress load, and the data was tabulated for further statistical evaluation. Many treated posts had failed to the point of unable to hold their own weight after 53 years.

The data from the evaluation was statistically analyzed using a variety of techniques (including assuming a Wiebull lifetime distribution and calculating 90% confidence intervals at the 60th percentile) and the results illustrate typical life spans for many of the preservative treated pine posts. The typical treated and untreated pine posts life span as approximated by the 60th percentile can be seen in the Tables 2 and 3 and Figure 2.

Example of 50 lb Pull test

Results from 1977 Inspection and FPL-01 Progress Report

Figure 1. Predicted *typical* service life of treated and untreated southern pine posts as given by the estimated 60th percentile for each treatment group taken directly from FPL-01 1977 Progress Report. (Note: An error in this printed Table is that the penta concentration was at 0.5% in the treating solution, and it was actually 5.0% w/w).

Type	Years
Ammoniacal copper arsenate	42
Copperized chromated zinc chloride	29
Chromated zinc chloride, F.R.	39
Coal-tar creosote, straight run, low residue	37
Coal-tar creosote, straight run, medium residue	40
Coal-tar creosote, medium residue, low in fraction from 235° to 270° C, crystals removed	40
Coal-tar creosote, low temperature	40
Lignite coal-tar creosote	30
Oil-tar creosote (Gasco)	37
Softwood-tar creosote (Termiteol)	27
Coal-tar creosote (medium residue, low in tar acids and naphthalene) 50 percent, and petroleum oil (No. 2 distillate) 50 percent (by volume)	34
Lignite creosote-petroleum (50-50)	30
Copper naphthenate (0.5 pct)-petroleum	42
Pentachlorophenol (0.5 pct)-petroleum oil (No. 2 distillate)	42
Pentachlorophenol (0.5 pct)-petroleum oil (Wyoming residual)	36
Highly aromatic (S.O.) petroleum oil	25
Aromatic, low residue (S.W.) petroleum oil	40
Highly aromatic high residue (S.O.) petroleum oil	26
No. 4 aromatic residual (California) petroleum oil	33

Results from 2003 Inspection

Summary of Data from February Inspection of MSP 29

Published data has been reported on this plot as part of the 1977 Progress Report titled "Comparison of Wood Preservatives in Mississippi Post Study" by U.S.D.A. Forest Service, Research Note FPL-01, July 1977.

This summary will include only the posts which are remaining after a subsequent inspection in 1990.

Table 1 will show the percentage of posts remaining for each preservative and retention. The method used to evaluate the posts is the one that uses the 50-lb load lateral pull test as prescribed in the Research Paper RMRS-RP17, "Service Life of Fence Posts Treated by Double-Diffusion Methods" by Donald C. Markstrom & Lee R. Gjovik.

Table 1. Preservative, solution retention, posts remaining from plot MSP 29 and percentages of pass, fail and missing of those posts evaluated.

53 years of exposure

CHEMICAL	RET.	% REMAINING After 1990	Inspection February 17-2003 Fail	Pass	Missing
ACA	0.34	64	4	12	0
Boliden Salt B	0.7	68	1	14	2
Carbosota (C-T Creo)	6.00	80	8	12	0
CZA	0.7	84	3	17	1
CZC (Copperized)	0.98	20	0	4	1
CZC (F. R.)	3.25	48	4	8	0
CuNap .5%Cu in Pet	6.00	72	4	13	1
Creo Straight Run Low Res.	5.9	32	4	3	1
Creo Straight Run Med Res.	5.6	56	4	8	2
Creo Straight Run High Res.	6	72	2	16	0
Creo Med Res Low Tar Acid	5.7	84	7	13	1
Creo Med Res Low Naph	6.1	84	6	13	2
Creo Med Res Low Tar Acid/Nap	6	68	2	15	0
Creo Low Res Low Tar Acid/ Nap	6	52	5	8	0
Creo High Res Low Tar Acid/ Nap	6.1	100	1	24	0
Creo Med Res Low Frac. 235- 270	6.1	72	6	9	3
Creo High Res Crystals Removed	6	96	2	22	0
Creo Low Temp	6.3	60	3	11	1
Creo English Vert. Ret.	6.3	64	6	9	1
Creo English Coke Oven	6	48	6	5	1
Creo Eng Vert Ret 50%/Coke Oven	6	76	5	12	2
Creo Med Res w/2 1/2% Penta	6	92	2	21	0
Creo 70% & C-T 30%	6.1	84	5	16	0
Creo 50% & Petro. Oil #2 50%	5.9	24	5	1	0

Creo 50% & Petro. Oil 50%	6	76	4	13	2
Creo 50% & Petr. Oil 50%/ 2 1/2%	6	92	0	23	0
Creosote, Oil Tar (Gasco)	5.9	40	3	6	1
GASCO In 2% PENTA	5.8	88	5	17	0
LIGNITE C-T CREOSOTE	6.3	16	3	1	0
Lignite CT Creo 50% & CT Creo	6.3	84	7	13	1
Lignite CT Creo 50% & Petro. Oil	6.4	24	5	1	0
Penta 5% in #2 Distillate	6.3	72	0	17	1
Penta 5% in #4 Aromatic Res.	5.9	96	1	21	2
Penta 3% In #4 Aromatic Res.	6	100	2	23	0
Penta 5% in Petroleum Oil	6	64	6	10	0
Penta 5% Cu Nap in Petro	6.2	96	2	21	1
Pertoleum Oil Aromatic High Res	6.1	60	6	7	2
Pertoleum Oil Aromatic Low Res	6.1	36	3	5	1
Petroleum Oil Highly Aromatic	6	4	1	0	0
Petroleum Oil High Aromatic Res	6.1	16	2	1	1
Petroleum Oil #2 Distillate	5.9	0			
Petroleum Oil #4 Aromatic Res	5.9	24	1	4	1
Petroleum Oil Wyoming Res	5.8	0			
PETROLEUM TERMITEOL	6.1	8	1	1	0
CONTROL	0	0			

Statistical Analysis

Analysis of the FPL-01 Post Series (1949 posts)

Several statistical analyses were conducted on the pass/fail data, including the parametric analysis described here. In estimating service life prior to 100% failure, it is noted that *typical* life is approximated by the time when 60% of the posts in a group have failed; this was assumed in prior reviews of this data and is referred to as the *average* service life. In prior reports, a mortality table was used for estimates of service life (the 60^{th} percentile) when between ten percent and close to 100% (but not 100%) of the posts had failed. If 100% of the posts had failed, then a formulaic average was calculated. Unfortunately, since several posts were lost for known and unknown reasons (eg., tree falling on posts) throughout the course of this exposure period, use of a mortality curve based on percentage failed or a formulaic average does not incorporate knowledge that these posts had survived for at least a known period of time. If we can assume an underlying parametric distribution for service life, we can better accommodate the censoring process. For this analysis, we assumed Weibull distributions, whereby the *typical* service life is then predicted by estimating the 60^{th} percentile.

Normal-approximation 90% confidence intervals on the 60^{th} percentiles were calculated (Meeker and Escobar, 1998). Table 1 lists these statistics in alphabetical treatment order, while Table 2 and Figure 2 lists treatments in order of predicted typical service life (note this is the 60^{th} percentile estimate and not the estimate of the average for the Weibull distribution).

Statistical calculations were made in SAS version 8.2 (SAS Institute Inc. 1999), while SPLUS version 6.1 (Insightful Corporation 2001) was used for graphing confidence intervals with dotplots. Note on several of the treatments, for graphing purposes, the upper limits of the confidence intervals were truncated. Please refer to Table 2 for the appropriate confidence interval values.

Further details will be available in a forth-coming Forest Products Lab report.

Table 2. Predicted *typical* service life of treated and untreated southern pine posts as given by the estimated 60th percentile for each treatment group.

Treatment	Estimated 60th Percentile Service Life	Estimated Standard Error	Asymptotic Normal 90% Confidence Limits	
			Lower	Upper
ACA	59.5	5.53	51.1	69.3
Boliden Salt B	73.1	9.29	59.4	90.1
CONTROL	2.4	0.16	2.1	2.7
CZA	76.7	9.75	62.3	94.5
CZC (Copperized)	39.2	2.94	34.7	44.3
CZC (F. R.)	52.3	4.38	45.6	60.0
Carbosota (C-T Creo)	62.5	5.81	53.6	72.8
Creo 50% & Petr. Oil 50%/ 2 1/2%	119.2	28.39	80.7	176.2
Creo 50% & Petro. Oil #2 50%	40.8	2.85	36.4	45.7
Creo 50% & Petro. Oil 50%	66.1	7.01	55.5	78.6
Creo 70% & C-T 30%	74.0	8.79	60.9	89.9
Creo Eng Vert Ret 50%/Coke Oven	64.0	6.47	54.2	75.5
Creo English Coke Oven	50.9	3.91	44.9	57.7
Creo English Vert. Ret.	56.6	4.90	49.1	65.2
Creo High Res Crystals Removed	105.4	20.50	76.6	145.0
Creo High Res Low Tar Acid/ Nap	154.0	51.82	88.7	267.4
Creo Low Res Low Tar Acid/ Nap	53.7	4.50	46.8	61.6
Creo Low Temp	58.2	5.41	49.9	67.7
Creo Med Res Low Frac. 235- 270	58.3	5.42	50.1	67.9
Creo Med Res Low Naph	67.6	7.17	56.8	80.4
Creo Med Res Low Tar Acid	66.4	6.72	56.3	78.4
Creo Med Res Low Tar Acid/Nap	66.8	7.10	56.2	79.6
Creo Med Res w/2 1/2% Penta	95.4	16.07	72.4	125.8
Creo Straight Run High Res.	71.7	8.52	59.0	87.1
Creo Straight Run Low Res.	45.7	3.42	40.4	51.6
Creo Straight Run Med Res.	54.0	4.67	46.9	62.3
Creosote, Oil Tar (Gasco)	48.8	3.85	42.9	55.5
CuNap 0.5%Cu in Petroleum	65.2	6.91	54.8	77.5
GASCO In 2% Penta	78.0	9.91	63.3	96.1
LIGNITE C-T CREOSOTE	37.8	2.64	33.7	42.4
Lignite CT Creo 50% & CT Creo	66.4	6.72	56.3	78.4
Lignite CT Creo 50% & Petro. Oil	39.4	2.70	35.2	44.0
Penta 5% in #2 Distillate	74.0	9.40	60.1	91.2
PETROLEUM TERMITEOL	32.4	2.32	28.8	36.4
Penta 3% In #4 Aromatic Res.	122.1	29.09	82.6	180.5
Penta 5% Cu Nap in Petro	105.0	20.44	76.3	144.5
Penta 5% in #4 Aromatic Res.	119.4	28.44	80.8	176.4
Penta 5% in Petroleum Oil	55.5	4.79	48.1	63.9
Petroleum Oil Aromatic High Res	54.4	4.55	47.4	62.4
Petroleum Oil Aromatic Low Res	47.7	3.66	42.0	54.1
Petroleum Oil #2 Distillate	7.7	0.53	6.9	8.6
Petroleum Oil #4 Aromatic Res	43.0	3.22	38.0	48.6
Petroleum Oil High Aromatic Res	34.0	2.44	30.2	38.2
Petroleum Oil Highly Aromatic	29.9	2.05	26.7	33.4
Petroleum Oil Wyoming Res	11.3	0.77	10.1	12.7

Table 3. Treatments ordered by increasing predicted *typical* service life. (Same as Table 1, but order by 60th percentile estimate.)

Treatment	Estimated 60th Percentile Average Service Life
Untreated SYP CONTROL	2.4
Petroleum Oil #2 Distillate	7.7
Petroleum Oil Wyoming Res	11.3
Petroleum Oil Highly Aromatic	29.9
PETROLEUM TERMITEOL	32.4
Petroleum Oil High Aromatic Res	34.0
LIGNITE C-T CREOSOTE	37.8
CZC (Copperized)	39.2
Lignite CT Creo 50% & Petro. Oil	39.4
Creo 50% & Petro. Oil #2 50%	40.8
Petroleum Oil #4 Aromatic Res	43.0
Creo Straight Run Low Res.	45.7
Petroleum Oil Aromatic Low Res	47.7
Creosote, Oil Tar (Gasco)	48.8
Creo English Coke Oven	50.9
CZC (F. R.)	52.3
Creo Low Res Low Tar Acid/ Nap	53.7
Creo Straight Run Med Res.	54.0
Petroleum Oil Aromatic High Res	54.4
Penta 5% in Petroleum Oil	55.5
Creo English Vert. Ret.	56.6
Creo Low Temp	58.2
Creo Med Res Low Frac. 235- 270	58.3
ACA	59.5
Carbosota (C-T Creo)	62.5
Creo Eng Vert Ret 50%/Coke Oven	64.0
CuNap 0.5%Cu in Pet	65.2
Creo 50% & Petro. Oil 50%	66.1
Creo Med Res Low Tar Acid	66.4
Lignite CT Creo 50% & CT Creo	66.4
Creo Med Res Low Tar Acid/Nap	66.8
Creo Med Res Low Naph	67.6
Creo Straight Run High Res.	71.7
Boliden Salt B	73.1
Creo 70% & C-T 30%	74.0
Penta 5% in #2 Distillate	74.0
CZA	76.7
GASCO In 2% Penta	78.0
Creo Med Res w/2 1/2% Penta	95.4
Penta 5% Cu Nap in Petro	105.0
Creo High Res Crystals Removed	105.4
Creo 50% & Petr. Oil 50%/ 2 1/2%	119.2
Penta 5% in #4 Aromatic Res.	119.4
Penta 3% In #4 Aromatic Res.	122.1
Creo High Res Low Tar Acid/ Nap	154.0

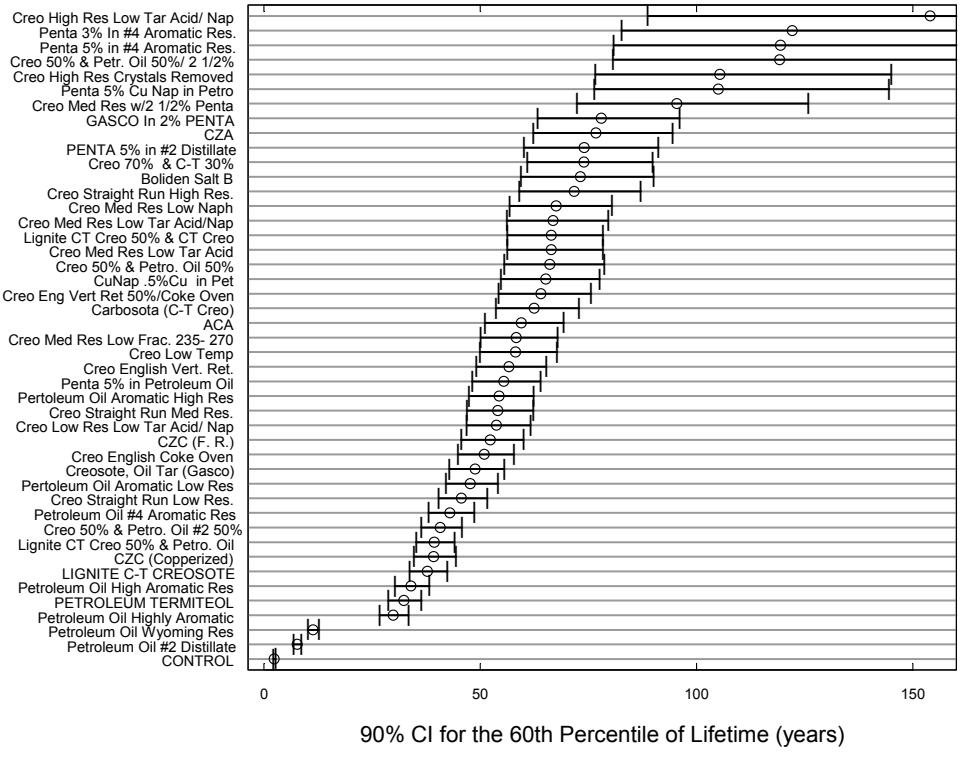

Figure 2. 90% confidence intervals for the 60th percentile of lifetime of posts impregnated with various treatments.

Results and Conclusions

Forty-four of the original preservatives still had serviceable posts in the MSP 29 Harrison, MS test plot after over 53 years of service when evaluated by a standard 50 pound lateral load pull test. Of note, were four systems, in particular, that are still in wide spread use today. Untreated southern pine fence post with an average diameter of 4-5 inches, failed in two years or less (estimated 60th percentile of 2.4 years) in the AWPA Hazard Zone 5 test plot. Posts treated with a highly aromatic # 4 fuel oil, ranged in service life, from 29 to 43 years, when treated to an average retention of 6 pounds per cubic foot (in the sapwood). Creosote, with low residue, what today is marketed, as "clean creosote" did not significantly extend its treated posts service life from the 1977 inspection, and that value increased from an average service life of 37 years, to a typical service life of 45 years. Penta treated posts, in P9-Type A oil (# 2 fuel oil) treated to a retention of 0.30 pcf penta, or 75% of the AWPA standard retention, had a typical calculated service life of 74 years. Surprisingly, copper naphthenate treated SYP posts, at roughly half of their specified AWPA retention for fence posts, have a calculated service life of 65 years. Copper naphthenate SYP poles used in AWPA Hazard Zone 5 require a retention of 0.13 pcf (Cu as metal), and these posts treated to less than one-quarter of that specified retention, in this severe exposure hazard zone have a calculated service life > 65 years.

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Bibliography

Anon. 1956. AWPA Standard M8-56. American Wood Preservers' Assoc., Stevensville, MD. 3 pp.

Anon. 1944. ASTM Standard Method D-2278. American Society of Testing and Materials. Philadelphia, PA. 4 pp.

Blew, J. O. 1947.Comparison of Preservatives in Mississippi Fence-Post Study After 10 Years of Service. Proceedings of the American Wood-Preservers' Association, vol. 43, pp. 26-41.

Davidson, H.L. 1977. Comparison of Wood Preservatives in Mississippi Post Study (1977 Progress Report). FPL-RN-01. USDA Forest Service, Forest Products Laboratory. Madison, WI. 17 p.

Insightful Corporation. 2001. *S*-PLUS 6 for Windows Programmer's Guide. Insightful Corporation. Seattle, WA. 986 pp.

Markstron, D.C. and L.R. Gjovik. 1999. Service Life of Fence Posts Treated by Double-Diffusion Methods. RMRS-RP-17. USDA Forest Service, Rocky Mountain Research Station, Ogden, Utah. 8 p.

Markstrom, Donald C. 1984. Service Life Of Treated And Untreated Rocky Mountain Area Fence Posts: A Progress Report. Res. Note RM-436, Fort Collins, CO: U.S. Department of Agriculture, ForestService, Rocky Mountain Forest and Range Experiment Station. 5 p.

Meeker, W. Q, Escobar, L. A. 1998. Statistical Methods for Reliability Data. John Wiley & Sons, Inc. New York, NY. 680 pp.

SAS Institute Inc. 1999. SAS/STAT® User's Guide, Version 8. SAS Institute Inc. Cary, NC. 3884 pp.

Stokes, M. E., Davis, C. S., Koch, G. G. 2000. *Categorical Data Analysis Using the SAS® System, Second Edition*. SAS Institute Inc. Cary, NC. 626 p.

Wirka, R. M. 1941. Comparison of Preservatives in Mississippi Fence-Post Study, Proceedings of the American Wood-Preservers' Association, vol. 37, pp. 365-379.