Effect of Preservatives on Fence Posts in Oklahoma

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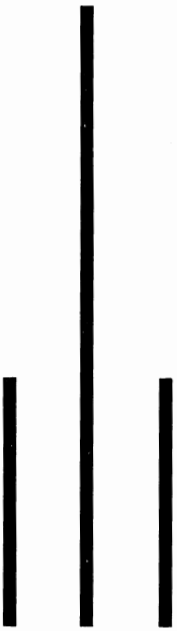

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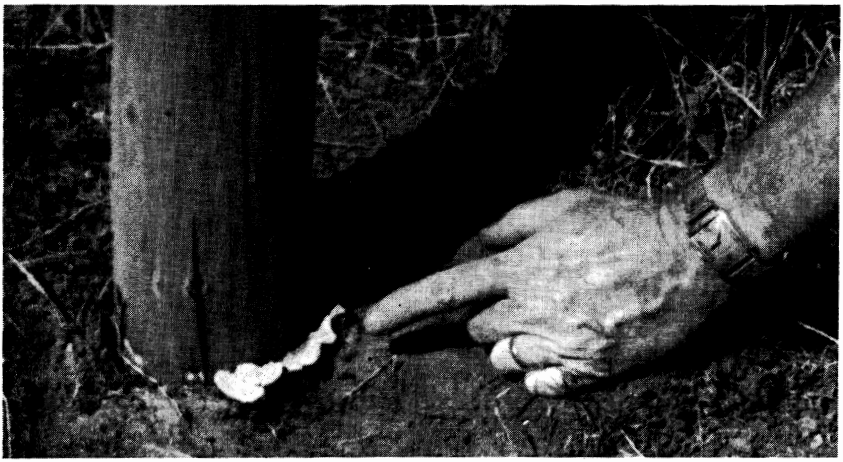

Untreated post showing signs of decay after two years of service testing.

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Edwin Y. Wheeler, E. R. Linn and A. C. Pakula*

Naturally durable tree species suitable for fence posts are becoming increasingly scarce in Oklahoma. However, extensive areas of the State support tree growth of species with little natural durability. Due to the relatively high costs of imported and preservative treated fence posts, a simple, inexpensive procedure for farm treatment of posts from non-durable species is desirable.

This bulletin reports results of a study to determine the effect of a cold-soak preservative on the useful life of posts made from non-durable tree species in Oklahoma.

PRESERVATIVE

Pentachlorophenol in a 5% solution with No. 2 fuel oil was used in this work. Toxicity is comparable to that of coal-tar creosote. However, due to lower viscosity, good penetration can be obtained at lower temperatures without pressure. Pentachlorophenol is highly resistant to leaching due to its low solubility in water.

In its pure form, pentachlorophenol is a crystalline organic chemical which will not dissolve in water or readily dissolve in oil. Consequently, it is generally sold as a high concentrate oil solution and then reduced to a 5% solution from the following formula:

$$\frac{\text{\% of penta in concentrate} - \text{\% of penta desired}}{\text{\% of penta desired}} \times \frac{\text{Weight of concentrate per gallon}}{\text{Weight of fuel oil per gallon}} = \text{Gallons of fuel oil needed per gallon of concentrate}$$

Research reported herein was done under Oklahoma Station project number 641.

*E. Y. Wheeler, Assistant Professor of Forestry, Oklahoma State University; E. R. Linn, formerly Associate Professor, now deceased; A. C. Pakula, formerly Assistant Professor, now with U.S. Forest Service.

EQUIPMENT

A treating plant was designed to permit vertical immersion of the posts in the preservative (Figure 1). Vertical tanks permit easy closure to prevent accidents and permit full advantage of the hydraulic effect of the treating liquid. (2)

Two treating tanks, eleven feet deep and thirty-six inches in diameter, were set nine feet in the ground to facilitate loading and unloading and to permit gravity flow filling from the preservative storage tanks. An electrically driven pump was used to force the preservative from the treating tanks back into the storage tanks.

A hand-operated hoist was used to load and unload posts from the treating tanks.

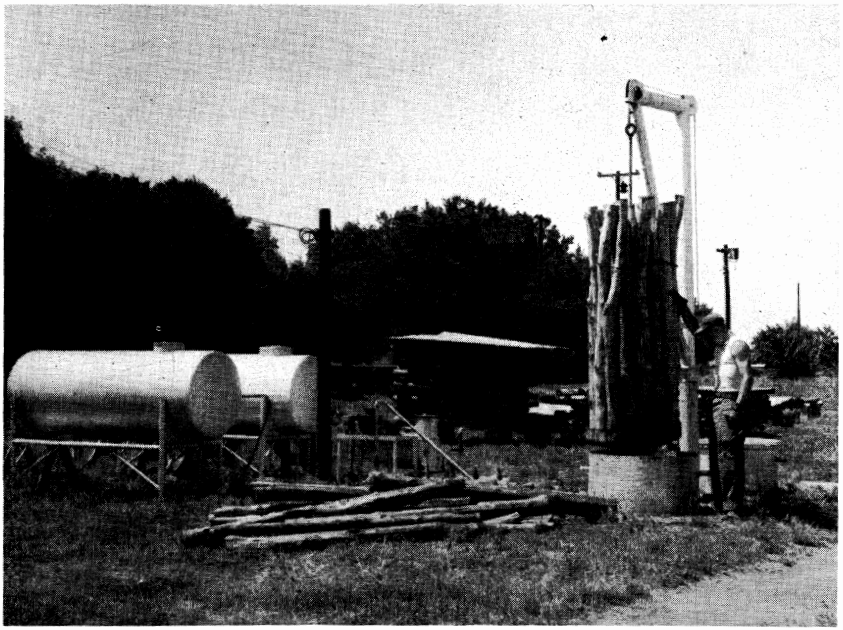

Figure 1. Experimental treating plant at Oklahoma State University.

POSTS

Species Used

Posts used in this study were cut near Lake Carl Blackwell, located in north central Oklahoma nine miles west of Stillwater. Blackjack oak (Quercus marilandica), eastern cottonwood (Populus deltoides), and black willow (Salix nigra) posts were treated and set out for service life determinations in August, 1951. Post oak (Quercus stelatta) posts were added to the study in June, 1952. In September, 1956, green ash (Fraxinus pennsylvanica var. lanceolata), bitternut hickory (Carya cordiformis), American elm (Ulmus americana), hackberry (Celtis occidentalis), and western soapberry (Sapindus drummondii) posts were treated and set out for service tests. Black locust (Robinia pseudoacacia) posts were added to the study in January, 1958.

Post preparation

All posts were cut in early spring to facilitate easy bark removal. Peeling was done with hand tools, such as a straightened garden hoe, sharpened automobile spring leaf, a draw knife, and a tight chain post peeler. (1)

In one study of blackjack oak, which is difficult to peel regardless of season, the bark was left on during seasoning. After seasoning, peeling was easily accomplished with a claw hammer.

One study of untreated blackjack oak posts was made by placing the posts in the ground without removing the bark.

Seasoning

Time of seasoning varied from five to sixteen months. The longer periods were due to delay in construction of the treating plant. In Oklahoma, one summer of seasoning is sufficient to dry posts below 20% moisture content. This moisture content level will permit free entrance of preservative without space competition from water in the wood cells.

Crib type piling, with about twelve inches of space below the pile, was used to promote rapid air drying. Piles were roofed to prevent rain soaking.

Treating

Posts of one species only were treated at one time. After loading the tank, posts were fastened down to prevent floating. Preservative

was added until the posts were immersed with enough excess to ensure coverage even after complete retention.

In most cases soaking was continued to the point of refusal, determined by cessation of further dropping of the preservative level in the treating tanks. After treating, the posts were piled to dry for one week to one month before setting in the ground. Treatment for a specific average retention was attempted in one case with black willow. Retention was estimated by the reduction of preservative in the treating tank while the volume of posts was known. Weight of preservative absorbed can be determined by measuring reduction of preservative level in the tank, if the diameter of the tank and the weight of a specific volume of preservative are known.

Since one gallon = .134 cubic feet

$$\frac{\text{Weight of one gallon of preservative solution}}{\text{0.134 cubic feet per gallon}} = \text{Pounds per cubic foot of preservative solution}$$

$$\text{Pounds per cubic foot of preservative} \times \frac{\pi d^2}{4} \times \text{Pounds of preservative solution absorbed} = \text{Tank level-reduction in tenths of feet}$$

d = diameter of the treating tank in feet

EFFECTIVENESS TESTS

Each post was weighed to determine dry weight before treating. After treatment each post was reweighed. The amount of preservative retained per post was determined by subtracting the original weight from the treated weight. This amount divided by the cubic foot volume of the post[1] provided a pound retention per cubic foot value.[2]

Tests of penetration were made on representative samples of blackjack oak posts after treatment using the "dye-bed" technique. The flat surfaces of short sections of split posts were pressed into a mixture of 75% finely divided calcium carbonate and 25% Nyanza oil red M-635. Depth of penetration was determined by measuring the resulting stained area from the outside of the post toward the center.

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[1] $\frac{\pi d^2/4 \times \text{Length in feet}}{144} =$ cubic foot volume of the post

d = diameter of the post in inches at the mid-point

[2] $\frac{\text{Treated weight} - \text{Untreated weight}}{\text{cubic foot volume}} =$ Pounds retention of preservative solutions per cubic foot of wood material

A service life test area was established one mile west of the Oklahoma State University campus on a clay loam soil. Average rainfall is approximately thirty-three inches per year. The growing season, related closely to insect and fungi activity, averages 213 days a year.

Ten replications of each treatment variation and species were established in the service life test area. All posts were checked yearly for deterioration and failure. Deterioration was determined by digging the earth away from the ground-line and probing the post with a knife. Failure was determined with a spring scale. A fifty-pound pull was applied to posts in four directions at four feet above ground level.

RESULTS

Table I shows comparisons of treated and untreated posts of all species tested.

Blackjack oak—untreated

Two controls were established with blackjack oak posts. In one, posts were set out for service tests with the bark on after seasoning for sixteen months. The other control group consisted of peeling the posts in the woods and seasoning for sixteen months prior to setting out for service testing.

The unpeeled posts have all failed. Service life averaged forty-two months or three and one-half years. Range of time for failure was between thirty-four and sixty months.

The peeled, untreated blackjack oak posts have all failed. Average life was sixty-five months or almost five and one-half years. Failure extended over a period from forty-eight to ninety-one months.

A Student "t" test was used to determine if peeling had any significant effect on post life. Significance was demonstrated at the 0.1% level.

Blackjack oak—treated

Two studies were made with treated blackjack oak posts. One group of posts was peeled in the woods, seasoned thirteen months, and treated. Another group of posts was seasoned with the bark on for sixteen months, peeled, and treated.

The posts peeled in the woods and seasoned were cold-soaked for ninety-six hours in the preservative solution. Average retention was 4.31 pounds of preservative solution per cubic foot. Retention in indi-

Table I. Comparison of Treated and Untreated Fence Posts from Different Tree Species, Stillwater, 1951 - 1962.

Species	Soaking Time	Avg. Dia.	Seasoning Time	Retention Max.	Retention Min.	Retention Avg.	Months in Service Range	Months in Service Avg.	Condition January 1962 Good No.	Good %	Partial Decay No.	Partial Decay %	Failed No.	Failed %	Month Set in Test Area
	Hours		Months	Pounds per cubic foot											
Blackjack Oak*	0	3.8	16	--	--	--	34-60	42	--	--	--	--	10	100	8/51
Blackjack Oak**	0	3.4	16	--	--	--	48-91	65	--	--	--	--	10	100	8/51
Blackjack Oak***	96	3.4	13	8.49	3.14	4.31	--†	125+	10	100	--	--	--	--	8/51
Blackjack Oak****	96	4.2	16	7.75	4.13	5.53	--†	125+	10	100	--	--	--	--	8/51
Eastern Cottonwood	0	4.0	16	--	--	--	34-60	40	--	--	--	--	10	100	8/51
Eastern Cottonwood	24	4.1	15	12.81	9.06	11.16	--†	125+	10	100	--	--	--	--	8/51
Black Willow	0	3.6	16	--	--	--	34-60	41	--	--	--	--	10	100	8/51
Black Willow	14	3.9	13	10.48	1.15	5.19	125††	125+	5	50	3	30	2	20	8/51
Black Willow	23	3.2	13	14.88	11.34	13.63	--†	125+	10	100	--	--	--	--	8/51
Post Oak	0	3.5	15	--	--	--	37††	84+	--	--	4	40	6	60	7/52
Post Oak	92	3.8	14	5.83	2.40	3.91	--†	114+	10	100	--	--	--	--	7/52
Green Ash	0	3.3	5	--	--	--	39††	55+	--	--	4	40	6	60	9/56
Green Ash	51	3.5	5	9.07	3.71	6.91	--†	64+	10	100	--	--	--	--	9/56
Bitternut Hickory	0	3.1	5	--	--	--	39††	54+	--	--	2	20	8	80	9/56
Bitternut Hickory	48	3.0	5	4.68	2.15	3.82	--†	64+	10	100	--	--	--	--	9/56
American Elm	0	3.9	5	--	--	--	30††	61+	--	--	6	60	4	40	9/56
American Elm	51	3.9	5	9.37	3.32	6.61	--†	64+	10	100	--	--	--	--	9/56
Hackberry	0	3.8	5	--	--	--	30-64	42	--	--	--	--	10	100	9/56
Hackberry	96	3.7	5	6.74	2.52	4.41	--†	64+	10	100	--	--	--	--	9/56
Western Soapberry	0	3.5	5	--	--	--	64††	64+	--	--	9	90	1	10	9/56
Western Soapberry	96	3.8	5	4.35	2.80	3.35	--†	64+	10	100	--	--	--	--	9/56
Black Locust	0	3.5	10	--	--	--	--†	48+	--	--	10	100	--	--	1/58
Black Locust	72	3.5	10	1.83	0.88	1.23	--†	48+	10	100	--	--	--	--	1/58

* Set in ground with bark on
** Peeled and dried before setting in ground
*** Peeled in woods, dried, and treated
**** Dried, peeled and treated
† No posts have failed to date
†† Posts started failing after the indicated number of months

vidual posts ranged from 3.14 pounds per cubic foot to 8.49 pounds per cubic foot. All posts were sound with no evidence of deterioration after 125 months or almost ten and one-half years of service testing.

Posts seasoned with the bark on before peeling were also cold-soaked in the preservative solution for ninety-six hours. Retention averaged 5.53 pounds of preservative solution per cubic foot. Range of retention in individual posts was between 4.13 pounds per cubic foot and 7.75 pounds per cubic foot. All posts were sound with no evidence of deterioration after 125 months or almost ten and one-half years of service testing.

A Student t test showed that difference in retention averages were not significant at the 5% level.

Blackjack oak bark was much easier to peel after seasoning. Insect activity between the outer bark and the wood loosened the bark. Although insect channels were found on the surface of the wood, there was no evidence of wood borer damage or decay.

Penetration of the preservative solution was ascertained for blackjack oak. Sapwood width on the post studied varied between 0.4 inches and 1.7 inches. The preservative solution penetrated 75% to 85% of the sapwood.

Eastern cottonwood—untreated

Control posts of eastern cottonwood were peeled in the woods and seasoned sixteen months prior to service testing. All posts have failed, demonstrating an average service life of forty months or three and one-third years. First failures were noted after thirty-four months, while the last post failed after sixty months.

Eastern cottonwood—treated

Treated eastern cottonwood posts were seasoned for fifteen months before cold-soaking in the preservative solution for twenty-four hours. Average retention of preservative solution was 11.16 pounds per cubic foot with a range from 9.06 to 12.81 pounds per cubic foot. Service tests show no failures or deterioration after 125 months or almost ten and one-half years exposure.

Black willow—untreated

After seasoning for sixteen months, the black willow control posts were set out for service testing. Failures started after thirty-four months

with the last post failing after sixty months. Average service life was forty-one months or almost three and one-half years.

Black willow—treated

Two studies of treated black willow posts were made. Both groups were seasoned thirteen months before treatment and service testing.

One study consisted of a fourteen-hour cold-soak treatment in which an attempt was made to control average retention at 6.00 pounds per cubic foot. It was found that although average retention was fairly close at 5.19 pounds per cubic foot, individual post retention was erratic ranging from 1.15 pounds per cubic foot to 10.48 pounds per cubic foot. In January, 1962, two posts failed and three other posts showed evidence of deterioration. These results are after service tests of 125 months or almost ten and one-half years. Five posts show no evidence of deterioration after the same length of exposure.

All posts that have failed or show evidence of deterioration had less than 4.0 pounds per cubic foot retention of preservative solution; whereas, the sound posts all had over six pounds per cubic foot retention.

The other study consisted of a twenty-three hour cold-soak treatment. This resulted in an average retention of 13.63 pounds of preservative solution per cubic foot. Variation between individual posts ranged from 11.34 pounds per cubic foot to 14.88 pounds per cubic foot. After 125 months or almost ten and one-half years of service testing there is no evidence of deterioration.

Post oak—untreated

After fifteen months of seasoning, control posts of post oak were set out for service testing. Exposure of 114 months or nine and one-half years has resulted in failure of six posts. The remaining four posts show evidence of extensive deterioration at the ground line. Failure of the first post occurred after thirty-seven months.

Post oak—treated

Post oak posts to be treated were seasoned for fourteen months. After ninety-two hours of treatment, retention averaged 3.91 pounds of preservative solution per cubic foot. Range in retention was between 2.40 pounds per cubic foot and 5.83 pounds per cubic foot. Service testing for 114 months or nine and one-half years has resulted in no evidence of deterioration.

Green ash—untreated

Green ash control posts were seasoned for five months prior to service testing. After sixty-four months or five and one-third years, six posts have failed with the first post failing after thirty-nine months. The remaining four posts show evidence of extensive deterioration.

Green ash—treated

These posts were cold soaked for fifty-one hours after seasoning for five months. Average retention was 6.91 pounds per cubic foot. Resulting range of retention was from 3.71 pounds per cubic foot to 9.07 pounds per cubic foot. Sixty-four months or five and one-third years of service testing have resulted in no failures or evidence of deterioration.

Bitternut hickory—untreated

Control posts of bitternut hickory were set out for service testing after five months of seasoning. Eight posts have failed after sixty-four months or five and one-third years, with the first failure occurring after thirty-nine months. Deterioration is prevalent in the two remaining posts.

Bitternut hickory—treated

Seasoning for five months preceded forty-eight hours of cold soaking the bitternut hickory posts. Retention averaged 3.82 pounds of preservative solution per cubic foot. Range in retention varied from 2.15 pounds per cubic foot to 4.68 pounds per cubic foot. Service testing for sixty-four months or five and one-third years has resulted in no failures and no evidence of deterioration.

American elm—untreated

After five months seasoning American elm control posts were set out for service testing. Four posts have failed after sixty-four months or five and one-third years, while the six remaining posts show extensive evidence of deterioration. The first failure occurred after thirty months of exposure.

American elm—treated

Fifty-one hours of cold soaking provided treatment for American elm posts that were seasoned five months. Retention ranged from 3.32 pounds per cubic foot to 9.37 pounds per cubic foot. Average retention

was 6.61 pounds per cubic foot. After sixty-four months of service testing all posts are sound and show no evidence of deterioration.

Hackberry—untreated

Hackberry control posts were set out for service tests after five months of seasoning. Sixty-four months later all of these posts had failed. Range of their service life varied between thirty and sixty-four months with an average service life of forty-two months or three and one-half years.

Hackberry—treated

Hackberry posts were seasoned for five months before cold-soaking for ninety-six hours in the preservative solution. Preservative solution retention averaged 4.41 pounds per cubic foot with actual retention ranging from 2.52 pounds per cubic foot to 6.74 pounds per cubic foot. All posts are sound with no evidence of deterioration after sixty-four months of service testing.

Western soapberry—untreated

Control posts of western soapberry were seasoned for five months prior to service life tests. One post has failed after sixty-four months of service testing; however, all other posts evidence varying amounts of deterioration.

Western soapberry—treated

Cold-soaking for ninety-six hours in the preservative solution followed a five-month seasoning period. Retention of the preservative solution averaged 3.35 pounds per cubic foot. Retention range was from 2.80 to 4.35 pounds per cubic foot. All posts are sound with no evidence of deterioration after sixty-four months of service testing.

Black locust—untreated

This species was set out for service testing after ten months of seasoning. Forty-eight months later all posts show some deterioration in the sapwood area.

Black locust—treated

After seasoning for ten months these posts were cold soaked for seventy-two hours. Average retention was 1.23 pounds per cubic foot with a range of 0.88 to 1.83 pounds per cubic foot. Forty-eight months of service testing have produced no evidence of deteroiration.

SUMMARY AND CONCLUSIONS

In 1951, studies were initiated to determine the feasibility of preservative treatment to increase service life of posts made from native timber in Oklahoma. A 5% solution of pentachlorophenol in No. 2 fuel oil was used as a preservative because of its toxicity, low viscosity, and resistance to leaching. The cold-soak preservative process was utilized due to simplicity and low plant investment. Untreated posts of each species were used as controls.

After four to ten and one-half years of observation, no deterioration was noted in properly treated posts. In one group of treated black willow posts, which had an erratic preservative retention rate, some failed and others showed signs of deterioration. All other treated posts remained in good condition.

Untreated control posts in all species except black locust have failed completely or demonstrate advanced deterioration due to decay and insects.

The service life of blackjack oak, eastern cottonwood, black willow, post oak, green ash, bitternut hickory, American elem, hackberry and western soapberry, can be greatly extended by soaking the posts in a 5% solution of pentachlorophenol in No. 2 fuel oil. Although this test is not completed, it is possible that service life expectancy can be increased to twenty years or longer.

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Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than $700,000,000 annually. The value added by manufacture of farm products adds another $130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.

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