PRESERVATIVES FOR WOOD POLES

Emergency Alternative Methods for the Standard Coal-tar Creosote Treatment

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PRESERVATIVES FOR WOOD POLES[1]

Emergency Alternative Methods for the Standard Coal-tar Creosote Treatment

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Coal-tar creosote may be considered as the standard wood preservative in the United States since out of the 278 million cubic feet of wood treated in 1944 more than 268 million cubic feet, or over 96 percent, was treated with creosote or solutions containing creosote (1)[3]. The current treating specifications of the Federal Government TT-W-571b, Recommended Treating Practice, recommend the use of coal-tar creosote, creosote-coal tar solution, or creosote-petroleum solution for the treatment of wood that is to be used in contact with the ground or water. For the treatment of telephone and power line poles straight coal-tar creosote only is recommended in this specification. The various pole treating specifications of the American Wood Preservers' Association also recommend the use of straight coal-tar creosote except for Douglas-fir, hemlock, and redcedar, for which either creosote or creosote mixtures may be used. Specifications of individual utility companies generally include similar requirements. With the increasing demand for creosoted wood and the limited supply of this preservative now available, producers and users of treated wood are facing a difficult situation.

The present demand for creosote is probably as great as or greater than at any time in the history of the wood preserving industry. In the face of this situation is the present standstill in production due to labor-management difficulties in the steel industry which is the important source of coal-tar. The continued shortage of creosote imports plus a domestic product which in certain respect has thus far failed to reach its prewar quality are other factors contributing to the present situation. The creosote outlook for 1946 is therefore not bright and many commercial treating plants may be forced to

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[3] Numbers in parentheses refer to citations listed at the end of this paper.

make a choice of either canceling orders or using some other preservative. The question therefore is "What preservatives are available as emergency alternates for coal-tar creosote?"

This question has been raised before and some thought has been given to methods of solution. At the start of World War II the Forest Products Laboratory made a study of the preservative supply situation and a paper "Preservatives, Priorities and Processes" by Hunt, Baechler, and Blew was presented at the 1942 meeting of the American Wood Preservers' Association (2).

Preservatives to Consider

It is not possible to predict, with any degree of accuracy, how far apart the creosote supplies and demands are going to be during the current year. It is safe to assume, however, that a substantial quantity of this preservative will continue to be available. There is no need therefore for a complete substitution of other preservatives. When it is necessary, however, to make a change to meet a local shortage the following preservatives can be considered as emergency alternates:

(1) Creosote mixtures

(2) Toxic oils other than creosote

(3) Water borne preservatives

Creosote Mixtures

There are a number of available products which can be used in mixtures with coal-tar creosote for the purpose of conserving the supply of that preservative. Because of the uncertainty of the value of some of these products, however, it is desirable if possible to use at least 50 percent coal-tar creosote in any mixtures that are used. Creosote-petroleum solution and creosote-coal-tar solution are preservatives that are not new to the wood preserving industry. Crossties have been widely treated with these solutions for many years and with complete success but they have found very limited use in the treatment of poles. Lodgepole pine and Douglas-fir poles pressure treated with creosote-petroleum (60-40 and 75-25 solutions) and installed by the Great Northern Railroad in Montana and Washington in 1928 and 1929 were reported to be showing no removals due to decay after 12 and 13 years' service (3). The Kansas Power and Light Company in 1916 and 1917 set 335 poles of southern pine pressure treated with a 6 pound retention of creosote-coal-tar solution near Abilene, Kansas (3). This oil was reported to have a 38 percent residue. Some of the poles were removed for various causes but of 252 remaining in service at the end of 22 to 23 years, none showed decay. Jack pine poles similarly treated have been used by the Canadian Pacific Railroad in Canada since 1926 and 1929 with no removals due to decay after 14 and 17 years of service (3).

Creosote-petroleum-pentachlorophenol mixtures are of recent use in the treatment of poles (4). There is also the possibility of mixing water-gas tar, wood-tar creosotes, and oil-tar creosote with coal-tar creosote. Oil preservatives and their respective merits will be discussed later but in using them as diluents or blending agents with coal-tar creosote it is important that they be compatible with the creosote and not cause sludging or other operating difficulties. The treating solution should also meet any special requirements, such as a clean surface and freedom from bleeding.

Toxic Oils Other than Creosote

Certain toxic oils other than coal-tar creosote are available to the wood-preserving industry although their availability may be limited in certain areas (2). Some have been tested in service so that their degree of effectiveness is reasonably well established; others are still unproven and their use is attended with greater uncertainty as to results. In either event, they should receive careful consideration.

Pentachlorophenol.--Solutions of polychlorinated phenols, principally pentachlorophenol, in petroleum solvents have been widely used by the armed services during the war. Tent poles and tent pins were treated by pressure and nonpressure impregnation methods while container plywood, boats, vehicles, and other wood products were treated by superficial methods with these preservatives. Poles have been treated with pentachlorophenol solutions since about 1941 principally by nonpressure treatments (5).

The toxicity of pentachlorophenol appears to be from 10 to 100 times greater than that of coal-tar creosote, depending upon the creosote and the toxicity values used for comparison (2). Even when diluted to 5 percent concentration, the toxicity of pentachlorophenol solution appears to be equal to or greater than the toxicity of the coal-tar creosotes in common use. From the standpoint of toxicity, 5 percent solutions of this chemical appear suitable for wood preservation when used in sufficient absorptions (2) (5).

Toxicity alone is, of course, no assurance of preservative effectiveness since permanence, as measured by chemical stability, volatility, and leachability in water, is equally important. In this respect, pentachlorophenol is reported to be highly satisfactory.

The commercial manufacture of pentachlorophenol was started about 10 years ago (5) and nine years ago the Forest Products Laboratory installed in Mississippi, experimental southern yellow pine posts that were pressure treated with waste crank case oil solutions containing approximately 5 percent and 3 percent pentachlorophenol (6). A recent inspection of these posts (see table 1) after nine years service showed 97 out of 99 posts treated with an average of 6.7 pounds per cubic foot of the 5 percent solution to be in good condition and two posts to have some decay. Of 99 posts treated with a similar retention of 3 percent pentachlorophenol solution, 96 were in good condition, two posts showed some decay, and one post was removed on account of decay. Of 98 posts treated with an average coal-tar creosote retention of 6 pounds per cubic foot, 90 were in good condition, and 8 showed some decay or decay and termite attack. Untreated posts had an average life of 3.2 years in this test.

The penetrating properties of the pentachlorophenol solution and the paintability of the treated wood are influenced chiefly by the solvents used in the solution. Light oils usually penetrate wood better than viscous oils. Oils with a viscosity as high as creosote or higher, however, cannot be expected to excel creosote in penetrating properties. Such oils are not likely to leave the wood in a paintable condition.

There is evidence to indicate that treating solutions made with the lighter fuel oils will not perform so well as those containing the heavier petroleum oils. Some petroleum solvents when heated with pentachlorophenol are likely to sludge and cause plant operating difficulties or dirty poles. Some progress has been made in the direction of finding solvents that are not objectionable from the standpoint of sludging.

The cost of pentachlorophenol treating solutions is understood to be favorable on a competitive basis with coal-tar creosote. It is estimated that a sufficient quantity of this preservative can be manufactured during 1946 to prepare from 25 to 35 million gallons of 5 percent treating solution. This is equivalent approximately to from 13 to 25 percent of the quantity of creosote and creosote solution consumed by the wood preserving industry during 1944 (1).

In an emergency, the use of pentachlorophenol solutions or creosote-petroleum-pentachlorophenol mixtures appears to be a safe alternate for coal-tar creosote if the requirements of existing creosoting specifications as to absorptions and retentions are adhered to. One investigator has recommended that the petroleum should have a flash point of not less than 190° F. as determined by the Pensky-Martens closed tester (ASTM Standard D-93), and a pentachlorophenol solvency of not less than 10 percent at 75° F. It should also be of such a quality that the treating solutions, with or without creosote, can be repeatedly used and heated during treatment without causing operating difficulties from undue sludging or gumming. Until suitable evidence is obtained to show that lower concentrations are adequate the pentachlorophenol solutions to be used as such or to be blended with creosote should contain 5 percent by weight of this chemical.

<u>Water-gas tar (2)</u>.--Most of the water-gas tar now being produced is used in road tars. The exact amount used in wood preservation, including that which is distilled to produce a creosote and that which is blended with coal-tar creosote, is difficult to ascertain. Water-gas tar varies greatly in viscosity according to the oil from which it is made, as well as the conditions of manufacture. Much of it is too viscous to be suitable for wood preservation but satisfactory absorptions and penetrations may be obtained with the less viscous tars. Service tests show that water-gas tar is a very good preservative when properly applied and is well worth considering as a substitute for coal-tar creosote for land use. For use with poles requiring a clean surface, however, it may be objectionable.

Low-temperature creosotes (2).--Low-temperature coal-tar creosotes differ in chemical composition from high-temperature coal-tar creosotes as shown by pronounced differences in a number of properties, such as specific gravity of fractions, sulfonation residue, tar-acid content, and naphthalene content. Some of them have given very good results in service tests. The total amount of these oils available for wood preservation is not large and apparently it is being used mainly in mixture with high-temperature coal-tar creosote.

Lignite coal-tar creosote, in mixture with coal-tar creosote and petroleum oil, has been used by one railroad company for some years. The limited service data thus far available fail to show that lignite-tar creosote is equal to coal-tar creosote, but in certain regions and under certain conditions its use may well be considered.

The Portland (Oregon) Gas and Coke Company, in carbonizing petroleum oils for the manufacture of municipal gas, produces an oil tar from which a creosote may be distilled. Some tests on this creosote by the block method indicate that it has considerable promise as a wood preservative.

Wood-tar creosotes (2).--Although wood-tar creosotes have been available in small quantities for many years, they have never been used extensively in pressure treatments. This has been due in part to the relatively limited quantities produced and, to some degree perhaps, to lack of sufficient standardization. For the most part, these products appear to have been sold for nonpressure use although there have been numerous exceptions.

No very positive statements can be made about the effectiveness of wood-tar creosotes because of the differences in character of the products obtained from different sources. The test data available indicate a considerable degree of effectiveness but do not show that the wood-tar creosotes can be safely assumed to be equal to coal-tar creosotes. Red oak ties with an absorption of about 10 pounds of wood-tar creosote per cubic foot in test for 26 years at Madison, Wisconsin, will probably have an average life of about 20 years. Another group of hardwood ties in the same test that are mostly red oak and were treated with 9 to 10 pounds per cubic foot of a 50-50 mixture of wood-tar creosote and coal-tar creosote will have an average life of about 22 years or more.

In the Forest Service fence post study in Mississippi (see table 1) southern pine fence posts pressure treated with 6.6 pounds of a wood-tar creosote per cubic foot were showing 25 percent replacements at the end of 9 years, which means that they will probably have an average life of only 12 to 15 years. In the Barro Colorado Island, Panama Canal Zone, tests also, the specimens treated with wood-tar creosote are not standing up so well as those treated with coal-tar creosote.

Though the evidence fails to indicate that wood-tar creosotes are equal to coal-tar creosotes in ability to prevent decay and termite attack, the wood-tar creosotes do have considerable protective value. They have been used occasionally in the past in mixture with coal-tar creosote, as an accommodation to the wood-tar producer. Opportunities may now occur where this would be of advantage to both the producer and the user of the wood-tar creosote, and thus serve to extend the supply of coal-tar creosote. When such mixtures are contemplated, it will be advisable to consider the quality of the wood-tar creosote very carefully and, if possible, have it meet a definite specification. High acidity and high volatility in the wood-tar product should be avoided. Tests should also be made to assure that the oils used will mix satisfactorily without producing a sludge during the mixing operation or subsequent heating.

Naphthenates (2).--Copper naphthenate and, probably, some of the other metallic naphthenates have considerable value as wood preservatives. They were used by the Navy during the war on wood boats. Their use, up to the present time, has been confined almost exclusively to surface applications which necessarily has limited their effectiveness and, until recently, they were sold only in proprietary preservatives. The growing interest in the naphthenates as preservatives appears to arise from the increasing quantities of naphthenic acids being produced as byproducts of the petroleum industry and the urge to find markets for them.

The effectiveness of the naphthenates as wood preservatives has not received adequate study and the time and extent of their use is insufficient to furnish conclusive information as to the absorptions that should be injected for best results. It is possible that petroleum solutions of copper naphthenate could be made to protect wood as well as creosote does but it remains to be seen what solution concentrations and absorptions would be necessary and whether they would be economically feasible. The fragmentary information available from various minor studies of copper naphthenate give favorable indications with regard to toxicity, permanence, and field tests. Brush treatments with a naphthenate preservative are said to have given only mediocre protection but apparently satisfactory protection results from substantial absorptions injected by pressure. Field tests were started in 1941 by the Forest Products Laboratory, in cooperation with a producer of naphthenates, in which surface and impregnation treatments in a variety of absorptions are being compared. These tests clearly demonstrate the inadequacy of superficial applications where protection against decay and termites is required. When applied by pressure, however, zinc and copper naphthenate preservatives are performing reasonably well.

It seems doubtful that copper naphthenate will be sufficiently plentiful or cheap in the near future to be of much use as a substitute for creosote in pressure treatments. At prices comparative with current creosote prices, however, copper naphthenate solutions would warrant serious consideration. They appear sufficiently promising to justify extensive experimental use even now, despite their present cost.

Water-borne Preservatives

The following water-borne preservatives are recommended in Federal Specification TT-W-571b for the treatment of wood not to be used in contact with the ground and water:

Zinc chloride	- 1.0 pound per cu. ft.
Celcure	- .50 pound per cu. ft.
Chromated zinc chloride	- .75 pound per cu. ft.
Wolman salt (Tanalith)	- .35 pound per cu. ft.
Zinc meta arsenite	- .35 pound per cu. ft.

Water-borne preservatives are subject to leaching and therefore will not perform so satisfactorily as creosote under wet conditions. Consequently their use for poles has been limited. They are capable of furnishing considerable protection against decay and termites, however, especially when used in dry climates. If emergency conditions seem to warrant their use in other areas a 50 percent or greater increase in preservative retention over that required in the above-mentioned specification should add substantially to their protective value.

Results on fence posts treated with these preservatives are shown in table 1. The Great Northern Railway during 1929 installed in Montana 3,725 Douglas-fir poles treated with one-half pound of zinc chloride and less than 1 percent of these poles were removed on account of decay during 12 years of service (3). Southern pine poles treated with zinc meta arsenite have been used with some success in various parts of the United States (3).

Other water-borne preservatives showing promise are Chemonite, Greensalt (ascu), and Osmose preservatives. These proprietary preservatives contain materials known to be effective against decay and termites and might be considered as emergency alternates for creosote. Osmose preservatives have been in use for the treatment of poles for approximately 10 years. Southern pine poles treated full length and installed in Alabama were reported to be showing satisfactory service after 6 years' service. Of the experimental fence posts treated with water-borne preservatives and installed by the Forest Products Laboratory in Mississippi, 4 percent have been removed and 80 percent are in good condition after 9 years (see table 1).

Methods of Treatment

A discussion of wood preservatives would not be complete without a few remarks concerning methods of applying the preservatives. Even the best preservative may fail to provide adequate protection if is carelessly or improperly applied. Good penetrations and adequate preservative retentions are therefore necessary for a successful treatment. Other things being equal, the treating process that best assures these results is the logical one to use.

There has been considerable emphasis placed upon nonpressure treatments for poles during the past few months. This has been due principally to the heavy demand and the insufficient supply of pressure-treated poles. Full-length nonpressure treatments are generally not on a par with full-length pressure treatments since absorptions and penetrations resulting from the nonpressure treatments are generally lower than for pressure treatments. When absorptions and penetrations are the same, however, the two treatments should be equal in value.

Service records on butt creosoted lodgepole pine and Douglas-fir poles installed in the Rocky Mountain region have shown this treatment to provide 25 or more years of service in that territory (3). This does not mean that the treatment will furnish the same protection elsewhere, however. Rainfall in parts of the Rocky Mountain area is only a few inches a year. The tops of the poles are therefore not wet for long periods and do not decay rapidly. No experience is available to show the actual life that may be expected from butt-treated pine or Douglas-fir poles in other regions although butt-treated fence posts of these species, even with a substantial heartwood content, show heavy decay in the untreated tops within a period of 9 to 10 years in Wisconsin. In more humid and warner climates top decay would be even more rapid.

Where woods of low or intermediate decay resistance are not treated in accordance with American Wood Preservers' Association Standards for full-length pressure treatment, it is suggested that their use should be confined to the zone between the 100th meridian and the summits of the Cascade and the Sierra Nevada Mountains until experience shows it is safe to use them elsewhere. Even in this territory there may be areas where experience would indicate that butt treatment is inadequate.

It is recognized that under present day conditions many compromises must be made if the users are going to get the poles they need. The situation is not yet so bad as to require a complete breaking down of the bars of good practice, however. Poles treated by recognized standard methods are still the best poles to buy. If it is necessary because of present creosote shortages to go to a different preservative, select the best that can be obtained but insist upon a method of treatment which will assure good penetration and adequate retentions. Where it is necessary to go to substandard treatments use them cautiously and only under conditions where a reasonable degree of success is definitely assured.

References

(1) Helphenstine, R. K. Jr., Quantity of Wood Treated and Preservatives Used in the United States in 1944. Proceedings of the American Wood Preservers' Association 1945, pp. 236-271.

(2) Hunt, G. M. et al. Preservatives, Priorities and Processes. Proceedings of the American Wood Preservers' Association 1942, pp. 62-84.

(3) Amadon, C. H. and committee. Report of Committee 7-7 - Pole Service Records. Proceedings of the American Wood Preservers' Association 1945, pp. 74-81.

(4) Rural Electrification Administration, Specifications and Dimensions for Poles, Supplement No. 1R to Engineering Memorandum No. 133R, Nov. 2, 1945.

(5) Hatfield, Ira, Information on Pentachlorophenol as a Wood Preserving Chemical. Proceedings of the American Wood Preservers' Association 1944, pp. 47-65.

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

Condition of round southern yellow pine experimental fence posts on the Harrison Experimental Forest, Saucier, Mississippi, after about 4-1/2 years' to 9 years' service

Treated posts set late in 1936, and later.

Inspected December 1945

Preservative	Posts in test[1]	Absorption of preservative[2]	Minimum	Maximum	Average	Standard deviation	Good		Serviceable but showing some – Decay		Decay and termite attack		Termite attack		Removed account of – Decay		Decay and termite attack		Termite attack		Total removed	
	Number		Pounds per cubic foot				Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Posts set late 1936 to February 1937																						
Boras-boric acid (50-50 mixture)	98	Salt	0.64	1.32	0.92	0.11	10	10.2	13	13.3	8	8.2	22	22.4	2	2.0	19	19.4	24	24.5	45	45.9
Beta naphthol, 5% (by weight) in oil mixture	99	Solution	3.9	10.0	6.2	1.3	21	21.2	9	9.1	19[a]	19.2	16	16.2	4	4.0	18	18.2	12	12.1	34	34.3
Celcure	96	Salt	.75	1.05	.92	.08	87	90.6	3	3.1	—	—	—	—	4	4.2	2	2.1	—	—	6	6.3
Chromated zinc chloride	99	Salt	.37	1.31	.87	.19	61	61.6	10	10.1	4[a]	4.0	11	11.1	7[a]	7.1	6	6.1	—	—	13	13.2
Coal-tar	99	Oil	1.6	19.2	6.5	2.9	74	74.8	8	8.1	9	9.1	5	5.0	2[a]	2.0	1	1.0	—	—	3	3.0
Coal-tar creosote, Grade 1	98	Oil	1.9	8.6	6.0	1.5	90	91.9	6	6.1	2	2.0	—	—	—	—	—	—	—	—	—	—
Coal-tar creosote 50%, used crank-case oil 50% (by volume)	100	Mixture[3]	1.6	14.8	5.4	2.2	95	95.0	5	5.0	—	—	—	—	—	—	—	—	—	—	—	—
Coal-tar creosote 10%, used crank-case oil 90% (by volume)	100	Mixture[4]	1.2	23.2	7.1	3.8	22	22.0	20	20.0	1	1.0	—	—	50	50.0	7	7.0	—	—	57	57.0
Crank-case oil (used)	100	Oil[5]	2.5	16.8	7.6	2.9	16	16.0	18	18.0	2	2.0	—	—	61	61.0	3	3.0	—	—	64	64.0
Lignite coal-tar creosote	98	Oil	1.1	11.6	6.3	3.2	59	60.2	11	11.2	18	18.4	2	2.0	3	3.1	4	4.1	1	1.0	8	8.2
Mercuric chloride	100	Salt	.05	.15	.09	.03	90	90.0	—	—	—	—	6	6.0	—	—	1	1.0	3	3.0	4	4.0
No-D-K	100	Oil	1.3	13.6	6.6	3.5	43	43.0	15	15.0	10	10.0	7	7.0	3	3.0	20[b]	20.0	2	2.0	25	25.0
Osmosar	97	Salt	—	—	.30[c]	—	80	82.5	11	11.3	2	2.1	—	—	2	2.1	2[d]	2.0	—	—	4	4.1
P.D.A. (phenyldichlorarsine) 0.84% in gas oil (by weight)	98	Solution	4.1	11.0	5.9	.9	33	33.7	11	11.2	10	10.2	32	32.7	1	1.0	6	6.1	5	5.1	12	12.2
Pentachlorophenol, 4.82% (by weight) in used crank-case oil	99	Solution	2.9	9.5	6.7	1.6	97	98.0	2	2.0	—	—	—	—	—	—	—	—	—	—	—	—
Pentachlorophenol, 3.08% (by weight) in used crank-case oil	99	Solution	3.1	11.4	6.4	1.8	96	97.0	2	2.0	—	—	—	—	1	1.0	—	—	—	—	1	1.0
Sodium bichromate	98	Salt	.59	1.14	.88	.11	39	39.8	4	4.1	7	7.1	35	35.7	1	1.0	4	4.1	8	8.2	13	13.3
Sodium chromate	93	Salt	.70	1.19	.93	.10	17	18.3	4	4.3	5	5.4	43	46.2	—	—	6	6.5	18	19.3	24	25.8
Tanalith	100	Salt	.20	.47	.35	.07	70	70.0	21	21.0	2	2.0	3	3.0	3	3.0	1	1.0	—	—	4	4.0
Tetrachlorophenol, 2.9% (by weight) in used crank-case oil	98	Solution	1.2	16.1	7.1	3.1	78	79.6	19	19.4	—	—	1	1.0	—	—	—	—	—	—	—	—
Tetrachlorophenol, 4.83% (by weight) in used crank-case oil	99	Solution	3.5	9.4	5.8	1.5	96	97.0	3	3.0	—	—	—	—	—	—	—	—	—	—	—	—
Water-gas tar	99	Oil	1.2	19.0	6.3	3.0	91	91.9	5[e]	5.1	—	—	3	3.0	—	—	—	—	—	—	—	—
Zinc chloride	100	Salt	.67	1.11	.94	.10	58	58.0	2	2.0	8	8.0	30	30.0	1	1.0	1	1.0	—	—	2	2.0
Zinc-meta-arsenite	98	Salt	.25	.54	.42	.06	96	98.0	2	2.0	—	—	—	—	—	—	—	—	—	—	—	—
Untreated posts (set February 1937)	55[f]	—	—	—	—	—	—	—	—	—	—	—	—	—	2	3.1	61	93.8	2	3.1	65	100.0
Posts set after February 1937																						
Untreated posts (set November and December 1938)	33[f]	—	—	—	—	—	—	—	—	—	—	—	—	—	11	33.3	21	63.6	1	3.1	33	100.0
($CuSO_4$, Na_2HAsO_4)[g] (Set Mar 1941)	100	Salt	—	—	(.35 (.16	—	98	98.0	1	1.0	1	1.0	—	—	—	—	—	—	—	—	—	—
Osmoplastic-groundline treatment (Set Feb. 1941)	100	Mixture	—	—	.34[h]	—	83[i]	83.0	3	3.0	3	3.0	9	9.0	—	—	—	—	2	2.0	2	2.0

Note: All preservatives, except copper sulphate-sodium arsenate, mercuric chloride, Osmoplastic and Osmosar were applied by pressure, the oils by the Rueping process and the salts by the full cell process. Mercuric chloride was applied by steeping and Osmosar and Osmoplastic by brush. The copper sulphate-sodium arsenate was applied by the double diffusion method. Seventy percent of the posts in each group are installed in well drained soil, 20 percent are in moist soil and 10 percent are installed in swamps.

[1]Installation included 100 posts for each treatment. This number has since been reduced in some cases due to losses by fire and pilferage.

[2]Based on the 100 posts treated in each group unless otherwise indicated.

[3]Absorption values based on 97 posts.

[4]Absorption values based on 89 posts.

[5]Absorption values based on 99 posts.

[a]Deterioration in one post at faces cut in pointing it for driving.

[b]Decay and termites apparently gained access to 2 posts through faces cut in pointing them for driving.

[c]Average application.

[d]Decay and termites apparently gained access to one post through faces cut in pointing for driving.

[e]Decay at bottom of one post which appears to have been cut off in setting.

[f]Untreated posts installed during 1937 had an average life of 3.0 years, those installed during 1938 had an average life of 3.6 years – Grand average for both groups – 3.2 years.

[g]Treated by double diffusion process.

[h]Average application per post – 15" band (3" above and 12" below the groundline)

[i]Not inspected below groundline, in order to avoid disturbing the paper bandage.

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