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What Can Supplemental Preservative Treatments Do

R, P. Leinfelder
Chapman Chemical Company

It must seem, to management personnel in the electric utility industry, that the field of wood technology as applied to wood preservation is more art than science and more conjecture than objective data. He is used to dealing in things which can be measured in ohms and volts, in a thousandth of an inch, and in dollars and cents. Unfortunately, treated wood poles are not like insulators, capacitors, transformers, etc. They differ as do the personalities of the people working for a utility and consequently, in dealing with wood poles, one must be ready to acknowledge the very considerable differences which can exist, and will exist, between poles cut from an identical environment and produced by the same supplier.

Much misleading information has come from the suppliers of forest products and preservative materials. While a good deal of this was based on scanty information, and therefore forgiveable, some of it is a result of either sloppy, or no real technical approach to the problem and therefore inexcusable. In this paper we would like to discuss the maintenance treatment of poles as it relates particularly to the western pole species which are of interest to most of you at this meeting.

Ideally, each and every pole should be seasoned thoroughly prior to treatment, so that the wood is checked to its maximum extent, under conditions where decay fungi will not have had an opportunity to become established in the wood. Next, the wood should be thoroughly treated with a non-leaching fungicide uniformly througout the entire piece of wood; enough fungicide should be impregnated to be considerably above the decay threshold. Unfortunately, none of these ideals are obtainable. The western species are produced in areas of high rainfall where ideal seasoning can not be achieved. To supplement air seasoning, steam conditioning and Boultonizing are done in the treating cylinder but poles will still check considerably after being set in line. Western species are mainly treatable only in the sapwood which averages from as little as 1/2 inch in thickness in cedar, to 1-1/2 inches in fir. This means that much of the wood is completely untreatable and, moreover, the sapwood of cedar, fir and larch is not as easily penetrated as in the case of the pines. To facilitate treatment of western redcedar it is recommended that the critical groundline area be incised to provide a good distribution of material.

In the thermal treatment of poles incising is also done on fir and larch poles. The type of treatments most used on utility poles are pentachlorophenol and creosote. Both of these preservatives are virtually insoluble in water and consequently have a low rate of leaching. However, despite this fact there is a steady depletion of concentration of these materials over a period of time and no matter how well a piece is treated, eventually the concentration of the penta or the creosote will not be sufficient to prevent a fungus from becoming established in the wood. Moreover, the amount of material it is possible to inject into a pole varies considerably from pole to pole. As an example, a recent study by the Bell Telephone Laboratories, which was a pole-by-pole evaluation of the retention of 932 freshly treated poles, showed the following:

Retention Less Than lbs./cu. ft.	Percent Of Poles (Cumulative Basis)
3	1.2
4	9.4
5	28.4
6	53.0
7	73.5
8	85.6
9	93.9
10	97.4
11	98.9
12	99.4
13	99.9
14	100.0

These poles had been treated in accordance with Bell Telephone specifications which call for an 8 lb, gauge retention. Note, however, that the actual average retention was 6 lbs. /cu.ft. an indication that gauge retentions are not synonymous with actual retention of material in the wood. The most interesting thing is the great variation between individual poles in the charge. In this study the lightest pole checked had 2 lbs./cu. ft. while the heaviest had 14 lbs. Moreover, retentions of less than 5 lbs./cu.ft. in the case of southern pine, result in early failures. In this sample 28.40/0 had less than 5 lbs./cu.ft of retention and hence will not perform in an acceptable manner.

It is not intended to be implied that one could draw the identical curve for douglas fir, western larch or even western redcedar poles. However, the principle undoubtedly holds true in these poles and one can expect variations from the average, meaning that in any charge of poles there are going to be some "weak sisters" which will not perform as well as expected.

To further document the truth of the spread of retentions we would cite a paper by F, P. Tierney and G. H. Lund which appears in the 1960 American Wood Preservers' Association Proceedings.

This paper shows the cumulative frequency distribution obtained in an extraction of 78 western redcedar poles which had been in service in the Northern States Power Company lines between 20 and 35 years. The results are as follows:

Retention Less Than lbs./cu. ft.	Percent of Poles (Cumulative Basis)

5	6
10	16
15	30
20	50
25	66
30	82
35	93
40	98
45	100

Here too, the average retention in the outer 1/2 inch in these cedars averaged 20 lbs, of creosote per cu. ft. but variations were experienced between 5 and 45 lbs./cu. ft. This, incidentally, is extremely good retention for poles this age and certainly demonstrates the economies and effectiveness of a rigidly controlled in-plant inspection program which Northern States Power has carried on for many years. The key to low cost maintenance, of course, starts in the treating plant; the better a piece of material is when it is treated, the longer it will be before maintenance begins.

In this same paper it is noted that on checking the strength of the creosote in these old poles, decay in this aged creosote was 10 lbs/cu.ft. Even in these extremely well treated cedar poles 16% had below threshold retentions of creosote. Here we see another important principle of maintenance in a thorough understanding of the toxicity of the preservative. Previously we had implied that 5 lbs./cu. ft. of creosote was a satisfactory amount to protect against decay. This is a rather flat statement as various creosotes differ in their toxicity and also differ in their toxicity to various fungus organisms. For practical purposes, however, many authorities think that a 5 lb. /cu. ft. figure can be used when dealing with most of the commercially available creosotes. We note that the aged creosote, reported on by Northern States Power Company, required twice as much to stop decay and this is due no doubt to the fact that creosote in aging loses its most toxic elements by evaporation. Hence, what is left has less strength.

Pentachlorophenol differs from creosote in that it is a crystalline solid which is dissolved in a petroleum carrier, normally in a 5% by weight solution. It is then applied to the wood as is creosote.

Unlike creosote there is no indication that it undergoes a weakening effect due to aging but there is a loss of penta with time. To cite a specific example, a line of penta treated southern pine poles belonging to the Wisconsin Power and Light Company showed a penta retention in the outer 1/2 inch below groundline, at 10 years of age, of 0.51 lbs. of penta per cu. ft. The same line sampled five years later showed the retention had dropped to 0.46 lbs. per cu. ft. or a 10% loss. At this rate the average retention of these poles will probably not reach the critical 0.15 lb. /cu. ft. retention until they are 45 years of age. However, dealing in averages is dangerous unless one remembers that it is possible to drown in a creek that averages one foot deep - if one steps into an eight foot hole.

Where Maintenance Treatment Fits In

The previous discussion has pointed out some of the problems inherent in wood poles and we will now illustrate how supplemental treatments can be employed to extend the useful life of timber in-place.

Pole Spraying: Originally all western redcedar poles were only butt-treated with creosote and, in later years, with pentachlorophenol. Cedar being a very decay resistant wood is able to give good service life above groundline with no treatment. Eventually, however, the tops of the cedar become vulnerable to fungal attack resulting in sap rot. This is disadvantageous for three reasons:

1) Decay getting established in the sapwood can find its way in back of the butt-treatment at the groundline causing serious deterioration of the pole at the groundline in spite of the 1/2 inch band of original preservative in this area.

2) Shell rotted cedar poles tend to burn more readily and hence a greater loss from ground fires will be experienced.

3) Probably the most important disadvantage is in the danger that sap rot presents to the pole climber. Sap rotted poles will not reliably hold lineman's hooks and become very dangerous to climb even though the strength of the pole, due to the durable heartwood, may not have been materially affected.

After a cedar pole has aged for a number of years and some superficial decay has started in the sapwood, the cedar sapwood becomes extremely easy to treat by means of a flow-on liquid application. Normally, a 6% to 10% penta solution is applied as a generous, coarse spray. This is done either by having an applicator climb the pole and apply the material directly to the pole with a spray-head or through the use of a "bucket-type" lift device. The material is flowed on to the pole generously to the point where the wood refuses to absorb any more. A double spraying of the top assures a more uniform retention.

The amount necessary to treat a particular pole varies with the size but, as an example, a Class 4, 40' pole normally requires about four gallons per pole and a Class 2, 70' would require 10 gallons per pole.

The retentions obtained by such applications on properly weathered poles run much higher than it is possible to obtain from poles freshly treated in the treating plant. The case for top spraying of cedar poles is an extremely easy one to make as the butt-treated sections of the poles will far outlast the tops, unless the cedar poles are sprayed, and the cost of a top spraying job will certainly pay for itself by deferring the need for expenditures which would be entailed were the pole allowed to deteriorate to the point where it needed to be replaced.

This information on pole spraying can be obtained in much greater detail from O. Floyd Hand, of Bonneville Power Administration, who has written a very definitive study of the evaluation of spray treatments of western redcedar poles. It should be noted that the top spraying of any other species is not recommended. The retentions obtained in spraying species with low heartwood durability are not likely to inhibit decay for any significant length of time.

Groundline Treatment

Since, at the groundline of the pole, there exists an area favorable to the growth of wood destroying fungi most poles eventually fail at this point. The groundline treatments available today are normally applied from about 4 inches above ground to 18 or 20 inches below groundline. In most areas this is the region where decay is most prevalent but there are situations where decay occurs lower than this and where this is found to be true, it is advisable to change the groundline treating practices to protect the threatened area. Normally these are dry areas, areas with light, well aerated soils or areas where poles are set in coarse gravel or rock fills. Since fungus requires air and moisture the optimum environment is found at a greater depth.

The groundline treating material is normally applied to the periphery of the pole and then wrapped with an oil-proof paper to give direction to the treating compound. Over a period of time the wood absorbs the chemicals from the material and it is diffused through the wood. Were the paper backing not used, the soil would have absorbed the preservative out of the treatment before it was available to the wood. While such treatment would result in a certain amount of soil sterilization it is felt that the material is of far greater durability when actually in the wood where it will not be subjected to severe leaching as it would in the soil.

Many of the claims for groundline treatment have been overblown and do need to be taken with a grain of salt. For many years companies have stated that it is possible to actually treat the pole better with a groundline treatment than it was treated initially. Such treatments are supposed to penetrate deeply into the heartwood and kill decay but such, unfortunately, is not the case.

The best groundline treatments available will preserve only 1 to 1-1/2 inches into the pole from the point at which they are applied. While it is true that many of these materials will show quantities of preservative existing 2 or 3 inches into the wood and that these quantities can be determined through the use of certain dye indicators, actual tests by the U. S. Forest Products Laboratory have shown that these quantities in no way inhibit decay. Groundline treatment can place a certain amount of preservative in the outer portion of a pole. Some of these products are significantly better than others and tests conducted by the U. S. Forest Products Laboratory have clearly brought out the differences between products of varying formulations. I would certainly recommend that any interested parties avail themselves of this information. The reports I refer to are The Study of Groundline Treatments Applied to Five Pole Species and Results of Groundline Treatments One Year After Application to Western Redcedar Poles by Edward Panek. These tests have shown results of groundline treating products on the commercially used pole species in climates representing the extremely wet and warm Gulf Coast area, the more arid regions at Fort Collins, Colorado and the moderate rainfall climate through the Midwest.

An indication of what these products are capable of is shown in the report by Edward Panek. The retention obtained with a 1/4 inch Pol-Nu treatment, after one year of exposure, was 0.883 lbs./cu. ft. of penta in the outer 1/2 inch. When one considers that the EEI Specification for original treatment of western redcedar is 1.00 lbs./cu, ft, it is evident that the retention obtained in this test closely approached that obtained in original treatment.

Other tests with Pol-Nu, also reported on by Panek, while not as spectacular as this were still very effective. Retentions in the outer 1/2 inch on freshly creosoted butt-treated cedar show a result of 0.447 lbs./cu, ft. after one year and untreated cedar, treated in a similar manner, showed 0.557 lbs. /cu. ft, after one year. A parallel study by the Northern States Power Company, by Tierney and Lund, showed Pol-Nu retentions on 44 poles tested averaged 0.40 lbs./cu.ft. after one year and 0.56 lbs. /cu. ft. on 20 poles tested after three years. It is evident that this material will dependably produce retentions in cedar of between three and five times the threshold for decay.

Results obtained on douglas fir, western larch and lodgepole pine have not shown as high retentions as were obtained on the cedar but they are still significantly effective. On poles treated at Madison, Wisconsin retentions in the outer 1 /2 inch, after two years of exposure, were as follows:

Douglas Fir	0.24 lbs./cu. ft.
Western Larch	0.27 lbs./cu. ft.
Lodgepole Pine	0.39 lbs./cu. ft.

In citing these retentions we have implied that a reten tion of 0.15 lbs./cu. ft. of penta will render wood sterile to decay. As there are probably about 2000 different wood rotters we would have to have 2000 actual threshold values for any preservative. However, for practical purposes even the most penta resistant fungi can be controlled with retentions ranging from. 0.15 to 0.18 lbs./cu. ft. of penta in the laboratory. In the field where conditions are seldom as optimum for the fungus as they are in the lab, lesser degrees of penta will no doubt suffice. A suggestion of this is brought out in an article, printed in the 1962 September issue of Electrical World, written by William C. Thompson of the Northern States Power Company. This paper shows a study of 16 western redcedar poles which had been given a superficial pentachlorophenol treatment on the tops in 1944 and at the time of re-inspection in 1961, showed no decay present even around spur marks. The average retention in the 16 poles at that time was only 0.06 lbs./cu. ft. and, consequently, it is obvious that on untreated cedar sapwood the decay threshold is lower in the field than the threshold by the ASTM method which is done on pine sapwood under conditions of optimum temperature and humidity for fungus growth. The main point of this article was, of course, to show the effectiveness of a pole spraying program.

The use of pentachlorophenol as a groundline preservative on old creosoted poles has one very definite advantage over other materials used for this purpose due to a very curious phenomenon which results when penta is mixed with creosote. Catherine Duncan and Audrey Richards, pathologists at the Forest Products Lab, reported that when as little as 0.77 lbs. of creosote was present in a southern pine block, in the standard ASTM soil-block test, the addition of only 0.03 lbs./cu. ft. of pentachlorophenol resulted in a threshold retention. This, when tested against the fungus most resistant to this combination, is remarkable when you consider that also in this test it took 0.12 lbs./cu. ft. of penta to achieve threshold and 4.8 lbs./cu. ft. of creosote. This, then, is a case of'2 plus 2 equals 10." Seriously, however, it does point up the distinct advantage of pentachlorophenol-creosote retentions. It is doubtful whether a pole having as little as 0.77 lbs./cu. ft. of creosote remaining in it would still be standing. Consequently, the effectiveness of a penta-base groundline material as a re-treatment for creosote poles is obvious. Even small amounts of penta will greatly strengthen the creosote treatment remaining in the pole.

<u>Timing In Preservative Treatment</u>

Obviously, if a pole has enough creosote or penta in it to prevent decay there is very little point in groundline treating it - just as you would not paint your house if your existing paint job made you happy. There is, however, a point in any group of poles when the retention of the individual poles retreats to the point where some of the poles start to decay. In any group of poles there is a range from the lowest to the highest and it gets to be a question of economics as to how much deterioration can take place before it is economical to apply a groundline treatment. A number of studies have been carried out on this and I would like to touch on some of these briefly.

R. G. Steiner and O. W. Weiss, of Union Electric in St. Louis, have found that 8 lb. southern pine poles start to show significant deterioration after 18 years in service. From a study of their installation costs it is found that they can afford to spend $21.40 per pole to groundline treat all poles at year 18 and at 8 year intervals thereafter to prevent this type of deterioration. Actually these grouundline treatments cost closer to $6.00 per pole and hence this utility feels it realizes a saving of some $15.00 per pole over the alternative which would be replacing poles as they go had. This study is particularly useful in that it does realize that not all poles can be saved by a groundline treatment and that due to obsolescence and losses for other reasons, same of the poles groundline treated will ultimately be removed anyway. In fact, it was assumed that over a 42 year period, even with groundline treatment, 54% of the poles would have to be removed for reasons other than groundline decay.

A little different approach to the economics of this is made by Mr. John Fried operations analyst for the Oklahoma Gas and Electric Company. Knowing nothing of the technical aspects of groundline treatment, he approached it as an operation analyst in computing what the costs of groundline treatment would be and endeavored to find out what the average life of the average pole would have to be to justify such an expenditure. This analysis included all costs for two methods of operation. One plan called for replacement of poles as they went bad and the second plan called an expenditure of $5.00 per pole at year 20 for groundline treatment and an additional expenditure of $5.00 every 8 years.

Interior Decay

The previous discussion of groundline treatments concerned itself entirely with protecting the outer layer of wood around the pole and pointed out that it is possible and feasible to perform groundline treatment on poles where there is reason to believe the remaining treatment is not adequate to prevent decay. Interior decay is, however, an entirely matter and usually comes from two sources.

1) During the seasoning process incipient decay becomes established in the wood to a depth where the treating process is unable to reach it and destroy it. Such a pole, when set, will develop decay which is usually concentrated in the area with the most favorable moisture content and which eventually causes failure. This appears to be a particular problem on the West Coast and in the South where temperature and humidity conditions favor fungus infection. Only good seasoning practices in the treating plant seem capable of controlling this. In the South, however, pre-treatment chemicals are being used with some success on southen pine poles.

2) Interior decay resulting from checks or breaks beyond re-treatment. The western species of poles are normally referred to as thin sapwood poles. Douglas fir can be treated as deeply as 2 inches but frequently penetrations can be much less. Cedar and larch have sapwood of 1/2 to 1 inch. This means that checks which develop after treatment can expose wood with no preservative in it.

While there is some natural durability in fir and larch heartwood, decay can eventually become associated with these checks and cause an internal failure. In lodgepole pine this is a particularly bad situation and here too, the most effective means of control would be in the plant. Since it does not seem likely that all poles will be seasoned to the point where checks are as large as they will get prior to treatment and also since many of the poles we are concerned about are already in place and checked, it may be desirable to treat the checks before decay has become established. As we have seen earlier, only the sapwood of cedar lends itself to the liquid treatment in the field. To successfully treat checks of fir, larch, cedar and lodgepole pine, it is necessary to use a material similar to a groundline treatment on these checks. It is important to force these materials deeply into the checks filling up, if possible, the entire check as the heartwood which is normally exposed in these checks is very difficult to treat and consequently all material possible should be brought in contact with the check. Normally, a high pressure spray such as Arco, Alemite or Crayco spray equipment should be used. In the opinion of this author it is not wise to use a regular groundline treating product for this use since most groundline products leave a residue behind which can cause the check to plug up and possibly trap moisture after a rain. This results in the checks actually holding more moisture than they normally would. For this purpose our company has designed Poi-Seal which fills up the check initially but after the penta petroleum solution diffuses into the pole it leaves a smooth plastic coating on both sides of the check serving as a water-repellent and not impeding in any way the drainage of the check. The success of such a check treating program has yet to be proven as very little of it has been done. However, from a theoretical standpoint such a program should eliminate decay associated with checks if initiated before decay has become advanced.

Internal Treatments

Many companies feature the internal treatment of rot pockets and our subsidiaries often perform this service. However, we feel that the worth of an internal treatment is suspect since the nature of decay in an internal pocket makes it difficult to get good distribution of a preservative to all portions of the rot pocket. It is relatively easy to move the preservative through the already softened wood, however, the sound wood on both sides of the pocket impedes the translocation of the chemical into these areas and we know that the decay hyphae may often be two to three inches or more into good wood. Consequently, such internal treatments, if effective at all, probably have limited usefulness. In the case, however, of insects appearing in the interior of poles, such as carpenter ants or termites, Chlordane or Dieldren in oil solutions have proven to be l00% effective. Since the insects do move around considerably in the void they will eventually all come in contact with the properly applied internal treatment and the colony will then be eliminated.

The author has attempted to cite one viewpoint on the effectiveness and usefulness of re-treatment chemicals and feels that, when they are applied in an intelligent manner, it will result in deferred expenditures and considerable savings to an electric utility. They must, however, be applied in conjunction with a program which is based on a knowledge of the particular problems involved and should be applied by personnel who are experienced not only in the method of application, but also who have a real appreciation of wood and its defects. It is hoped that the papers presented here and the questions put to the panel members will help each of you go home and prepare a pole purchasing and maintenance program tailored to your individual needs. During the course of this paper I have alluded to many technical reports which explain more fully some of the points I have endeavored to make. Consequently, I am listing the reports and their authors and would hope that, should you wish to obtain any or all of these, you would address your requests to me at 252 Sexton Building, Minneapolis, Minnesota.

Study of Groundline Treatments Applied To Five Pole Species
by Edward Panek and J. Oscar Blew

Utility Pole Controls
by F. P. Tierney and G. H. Lund

Results of Groundline Treatments One Year After Application to Western Redcedar Poles
by Edward Panek

How To Evaluate Preservatives For Groundline Application To Standing Poles
by Chapman Chemical Company

Evaluation of Pentachlorophenol Spray Treatment of Standing Power Poles
by O. Floyd Hand

Supplemental Treatment of Standing Poles
by R. G. Steiner and 0. W. Weiss

Fortified Wood Preservative for Southern Pine Poles
by G. Q. Lumsden

When Is It Economical to Start a Groundline Treating Program
by Wayne Johnson