DECAY MANAGEMENT: PREVENTING AND CONTROLLING DETERIORATION OF WOOD POLES

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INTRODUCTION

In spite of our increased use of steel, concrete and fiberglass to support electric transmission and distribution systems, countless miles of lines will continue to be supported by wood poles. In addition to its ease of handling, low costs, and high strength per unit weight, wood is renewable and does not require large amounts of energy to process the finished products. For this reason, it is essential that we continue to develop improved methods for prolonging the service life of these structures.

Wood is remarkably durable material that resists attack by a variety of agents when properly used; however, wood used improperly can be rapidly degraded by bacterial, fungi and insects. Wood decay organisms require a food source (the wood), adequate moisture, oxygen and temperature. It is very difficult to control temperature or oxygen, but moistsure can be controlled in wood buildings by careful design. Moisture control is generally not practical in utility poles, although the use of kerfing to limit check development canminimize some moisture problems (9, 15).

The most practical aspect of decay control involves preservative treatment to produce a well treated protective barrier. Preservative treatment of thick sapwood species such as the southern pines, results in treatment penetrating 7.5 to 10 cm from the surface, but treatment of large diameter western wood species, such as Douglas fir, results in a 2.5 to 5.0 cm thick, solid shell of preservative-treated sapwood surrounding an untreated, moderately decay resistant core. As long as this shell remains sound, the pole will be protected; however, any practice that penetrates the treated shell will permit the entry of decay fungi and moisture into the heartwood core. These practices include improper (shallow) preservative treatment, cutting or drilling through the treated shell after treatment, and check development. Of these problems, check development poses the greatest problem for wood poles.

Generally, large diameter poles can not be economically seasoned to in service moisture levels prior to treatment. As a result, treated poles may be installed while the heartwood moisture content is well above 30 percent. The poles continue to dry in service and develop deep checks that can act as avenues of entry for decay organisms.

Several methods of limiting check development will be discussed, but few utilities take advantage of these techniques and we continue to experience relatively high levels of internal decay in large diameter wood poles (7).

Eliminating and preventing decay should be the goal of every utility's wood management program. Wood management has been substituted for wood maintenance because it more closely reflects the purpose of a utility's wood program which involves achieving maximum service life from wood at minimum cost. This will insure that the utility maximizes the return of its original investment.

DETECTING DECAY

While controlling decay is an important aspect of a wood management program, identifying decayed wood before significant strength losses occur is the most critical aspect of such programs. Detecting decay will be the subject of other presentations in this meeting, but a few points will also be made here.

Decay Detection Methods

Detecting decay in the earliest stages still poses the most difficult task for a wood inspector (10). Yet, it is at this point that the wood still retains much of its original strength and remedial treatments are most effective. Unfortunately, the inspector is rarely given a fair chance, and many utilities still depend on sounding with a hammer to detect hollow poles (4). While this process will detect very badly decayed poles, the point when they are detected leaves the utility with replacement as their onlyoption.

In addition to sounding, there are several other commonly used methods for detecting decay, including drilling and coring. Drilling into the wood at or below the ground line can alert the inspector to the presence of pockets or voids. In addition, the inspector can "feel" weak portions of wood by the difficulty of drilling and can examine the drill shavings for the presence of decay. Coring with an increment borer can also detect the presence of voids, but has the advantage of producing a solid wood core that can be examined to determine the location and size of decay pockets. In addition, the depth of preservative penetration can be measured and the core can be cultured for the presence of decay fungi to provide a measure of the future risk of wood decay.

The more sophisticated methods of decay detection involve sonic testing. This method began with the Pol-Tek, which used sonic velocity to detect the presence of wood voids. This device was too variable for most species; however, it stimulated the development of more sophisticated sonic test methods. At least three universities and one Canadian utility are presently attempting to develop sonic tests, based upon combinations of wave velocity and stress wave analysis. At present, only one of these devices has been commercialized for utility poles, but this device is not yet widely used. As these devices become more refined, the ability to detect decay before substantial damage occurs will markedly improve the overall effectiveness of wood management programs.

DECAY CONTROL

Once decay has been detected, the inspector is next confronted with decisions about how to best protect the sound wood remaining in a structure.

The first decision depends upon the amount of residual strength remaining in the pole. If the structure is deemed worth saving, the use of reinforcements may be advisable. Reinforcement can involve the use of pole stubs, c-braces, or more elaborate reinforcement devices. The selection of braces will depend on the position of the pole, the degree of decay, and the amount of money available to purchase pole reinforcement devices.

In addition to reinforcing the pole, it is critical that the existing decay be rapidly arrested to prevent continued strength loss. When the poles contain surface decay, the decay control decisions are rather simple, and generally involve the removal of the softened wood with a scraper and application of a preservative-containing wrap. The decayed wood has little or no residual strength and will absorb chemical that can be put to better use in the sound wood below. Surface decay appears to be more of a problem with the southern pines (17), although Douglas fir treated with pentachlorophenol by the Cellon process appears susceptible to surface attack. External wraps previously contained creosote, pentachlorophenol and several water soluble salts, but some users have substituted copper naphthenate in these wraps in light of the increasing restructions on the use of penta.

While preservative-containing wraps will control surface decay, the chemicals in these wraps can not migrate into the wood at a sufficient rate to control decay deep inside the wood (2). At one time, decay beyond the outer shell was vitually uncontrollable; however, the use of volatile agricultural soil sterilants have revolutionized the control of internal decay. The first field stests of the fumigants Vapam (sodium n-methyldithiocarbamate), Vorlex (20% methylisothiocyanate, 80% chlorinated C_3 hydrocarbons), and chloropicrin (trichloronitromethane) are now 17 years old and indicate that fumigant treatment rapidly eliminates decay fungi from Douglas fir heartwood and prevents fungal reinvation for periods ranging from 6 to 17 years (Figure 1) (6,8,13). Vapam, the most easily handled of the chemicals tested, has provided the shortest period of protection, ranging from six to ten years and volatile fungicides are normally not detected in the wood two years after treatment with this chemical. By itself, Vapam is not highly fungitoxic, but it degrades in contact with wood to produce a number of highly effective fungicides. Until recently, we thought that the major fungitoxic

component of Vapam was methylisothiocyanate (MIT); however, preliminary studies indicate that a number of other compounds are formed. Studies are now underway to determine how these compounds function in the long term protection provided by Vapam treatments. The remaining two chemicals, Vorlex and chloropicrin, have protected Douglas fir for 17 years, while Vorlex was detectable fourteen years after treatment. The long term performance of these three fumigants has encouraged electric utilities to include routine fumigant treatment in their wood management programs and 85% of utilities in the United States regularly use fumigants (4). At present, Vapam, Vorlex, and chloropicrin are the only formulations registered in the U.S. Environmental Protection Agency for application to wood; however, these chemicals are all liquids that carry with them considerable risk of spills.

To overcome these risks, a group of electric utilities are supporting research at Oregon State University to develop improved formulations of currently registered chemicals and to identify the next generation of safer fumigants (13, 14). Efforts to improve fumigant application have taken two approaches; the use of encapsulating agents to retain the chemical prior to treatment or slow its release into the wood, andmore basic studies of how the currently registered chemicals move through the wood. In the former effort, gelatin has been used to encapsulate Vorlex and chloropicrin, permitting safe application above the ground line. Addition of water at the time of treatment breaks down the gelatin and releases the chemical. Field tests of encapsulated formulations indicate that the gelatin has no effect on performance; however, the high cost of encapsulation has, so far, limited application. Vapam can not encapsulated because it is aqueous, but there may be other methods for improving application. One such method involves the use of high pH buffers to modify the rate of Vapam decomposition to MIT. Preliminary tests indicate that both the decomposition rate and the types of products produced can be altered by the pH of the buffers applied at the time of treatment. Support for studies to improve encapsulation methods are currently being contemplated by the Electric Power Research Institute, but these advances are some years away.

While encapsulation can substantially improve the safety of fumigant treatment, we still know very little about how fumigants move through wood to provide prolonged protection. This information can be used to develop models to improve chemical application methods. Unlike soil, where fumigants are rapidly degraded, laboratory studies indicate that high levels of both chloropicrin and MIT are strongly absorbed into the wood (5,18,19). These levels are affected by wood moisture content at the time of treatment and the presence of decayed wood. Both chemicals are able to migrate readily through wood at moisture contents below 50 percent; however, the rate of chemical movement declines rapidly above this moisture level. The inability of fumigants to migrate through very wet wood will be less effective at long distances from the point of application, although treatment effectiveness appears to be enhanced by the addition of water to previously fumigated wood (19). This enhancement is characterized by a rapid release of chemical from the wood to provide rapid fungal control at the time when conditions are most conducive for decay development.

Understanding fumigant properties in wood will eventually permit identification of chemical dosages, treatment pattersn and retreatment schedules for optimum decay control.

While currently registered fumigants have provided excellent protection to utility poles and will continue to do so for the foreseeable future, it is important that efforts continue to identify safer, more effective fumigants (14). New fumigant research has concentrated on solid chemicals that can be applied with minimal risk of spills. These efforts have identified methylisothiocyanate (MIT), tridipam and Mylone. MIT is a solid that sublimes directly to a gas at room temperature and has performed as well as Vorlex or chloropicrin in field tests (12). MIT is caustic and must be encapsulated for safe handling. Gelatin encapsulation has permitted safe application of this chemical and does not appear to affect fumigant effectiveness (18). Although MIT appears promising, the high cost of registering new fumigants, coupled with the need to economically contain the chemical prior to treatment, have stymied commercialization of this chemical for wood use.

Mylone and tridipam are two other fumigants which are both crystalline solids at room temperature but, unlike MIT, these chemicals are much more stable. Both Mylone and tridipam decompose to produce MIT and other fungitoxic compounds; however, the rate of decomposition is normally quite slow. For this reason, these chemicals have been overlooked, but field tests indicate the Mylone can control decay fungi in Douglas fir timbers (3) and laboratory tests indicate that the rate of decomposition for both chemicals can be substantially improved by adding basic buffers at the time of treatment (16). The latter approach offer sthe opportunity to tailor fumigant treatment to a particular decay problem. For example, poles contianing active decay pockets would receive dry chemical along with a liquid at pH 12 (basic pH) to increase the rate of decomposition and rapidly control decay. Conversely, long term protection of sound wood could be obtained by adding dry chemical alone or with a small amount of less basic pH buffer (pH 7 to 10). This tailored approach will permit the inspector to incorporate inspection results with the chemical application. More recent tests indicate the Mylone can be pressed into hard pellets which can be coated for ease of handling. These pellets decompose to release MIT when water is added. Plans are underway to evaluate these formulations under field conditions.

THE FUTURE

Although we continue to emphasize remedial treatments of existing structures as the primary application for our results, it is clear that the best time to treat a pole with fumigants is after pressure-treatment and prior to installation. At this point, the pole retains maximum strength, has fewer defects that might absorb chemical, and can be safely treated along its full length. Two lines have been treated by Oregon State University prior to installation. Although the process was initially slow, it became fairly routine and the cost per pole for the second line was approximately thirty dollars. While this cost may be too high for use on smaller distribution poles, it is more than offset by the improved safety on larger structures. We believe that pre-installation fumigant treatment provides the simplest method for retaining the original designed strength of wood poles.

CONCLUSION

While fumigants have been studied for wood treatment for nearly twenty five years, we are just beginning to understand how these chemicals move through and protect wood. As we learn more, we can begin to apply this information to improve treatment practices and prolong wood service life.

At present, fumigant use is limited to ground line application of Vapam, chloropicrin, or Vorlex; however, continued research and testing should lead to safer formulations that can be delivered in a controlled fashion to any wood structure. As these applications occur, the savings in wood investments currently noted ($2.25 million per year by Bonneville Power Administration and $7 million per year by New York State Electric and Gas Corporation) (Anon, 1980) should rise substantially, making wood management programs more attractive to corporate managers.

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Figure 1. Ability of Vapam, Vorlex, chloropicrin, allyl alcohol, or methylisothiocyanate to eliminate and prevent colonization of preservative treated Douglas fir poles by decay fungi as measured by culturing increment cores.

FIGURE 1