Effect of Initial Preservative Treatment on Electrical Conductivity in Douglas-Fir Pole Sections

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Abstract

The effect of copper naphthenate treatment on electrical resistance of Douglas-fir utility poles was compared with similar poles either left untreated or treated with pentachlorophenol (penta). Penta-treated and untreated wood had similar electrical resistance shortly after treatment and after a 3-month outdoor weathering period. Electrical resistance of copper naphthenate–treated wood was more variable but consistently greater, indicating that poles treated with this chemical would not pose an increased risk to utility personnel working on them.

Wood poles provide an ideal support for overhead electrical distribution and transmission lines. One important attribute of wood is its excellent insulation properties compared with other materials, notably steel. Electrical resistance, which is the opposition offered by a substance or body to the passage of electrical current, is important in utility lines due to charges potentially being conducted from the wires onto the pole where line personnel could come into contact with them (Stewart 1936). Untreated wood is considered to be a good insulator for supporting overhead lines, but most poles must be supplementally protected with preservatives to provide adequate service life. Utilities have long been concerned about the potential effects of treatment on conductivity (Stewart 1936, Darvenza et al. 1967, Clark and Donaldson 1969, McIntyre and Fox 1990).

Some preservative treatments can affect electrical properties of wood, particularly at higher retentions (Clark and Donaldson 1969, Morris and Dickinson 1984, Homan and Holleboom 1998). The measurement of mobility of metallic elements in the wood has also been used as a method for assessing preservative fixation (Evans and Nossen 1989, 1991).

The primary chemicals used in the United States for wood pole treatment are pentachlorophenol (penta) in heavy oil, chromate copper arsenate, and creosote. While chromate copper arsenate has the potential to increase conductivity, the effects are generally slight (Katz and Miller 1963). Penta, by virtue of its oil system, and creosote have little effect on conductivity. Recently, a number of utilities have added copper naphthenate to their specifications, and the presence of copper, a metal well known for its electrical conductivity, has raised questions about the potential impacts of this treatment on conductivity. While the amount of copper in a copper naphthenate–treated pole is small in proportion to the amount of treatment chemical and solvent (approximately 0.054% Cu in the assay zone for the highest retention for Douglas-fir and approximately 0.21% over the entire cross section; American Wood Protection Association [AWPA] 2009), it is important to verify that the presence of even this small amount of metal does not adversely affect conductivity.

In this report, we compare the electrical resistance of nontreated, copper naphthenate–treated, and penta-treated Douglas-fir pole sections.

Materials and Methods

There is no standard method for measuring conductivity or electrical resistance of treated wood poles. As a result, we developed our own method, based upon readily available instrumentation and personnel safety.

Ten nontreated Douglas-fir pole sections (4.8 m long) cut from Class 4 13-m-long poles that had been seasoning for approximately 4 months were each cut into three 1.2-m-long sections. The 1.2-m sections were allocated to be left

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untreated or treated to the AWPA Use Category 4b retention with penta or copper naphthenate in solvent conforming to AWPA Standard P9 Type A (9.6 and 1.2 kg/m^3, respectively; AWPA 2009). The fourth section from each pole was stored under cover in case additional testing was required. Each section was end coated to retard longitudinal preservative penetration, thereby simulating a section from a large pole. The pole sections were pressure treated in commercial facilities located in Eugene or Sheridan, Oregon.Six nontreated pole sections along with 10 sections each treated with copper naphthenate or penta were included in the tests.

The treated and nontreated pole sections were stored outdoors prior to conductivity testing and were subjected to approximately 1 m of rainfall and ambient temperatures that ranged from 0°C to 13°C. Moisture contents at the time of testing were well above the fiber saturation point, creating excellent conditions for electrical conductivity.

Two Delmhorst Teflon-coated 37.5-mm-long moisture meter pins were driven to a depth of 31 mm into the wood, approximately 225 mm inward from each end (Fig. 1). The resulting pins were then 750 mm apart. One pin at each location was used to measure resistance when the pole sections were subjected to high voltages. Two steel nails (Stanley Bostitch 3.375 mm in diameter by 87.5 mm long) were driven to a depth of 31 mm in line with the two moisture meter pins so that a nail was approximately 225 mm from its respective moisture meter pin. This resulted in the nails being 300 mm apart.

A Fluka DVM Model 77 with an impedence greater than 10 MΩ was attached to the two nails, and an AEMC Model 1000 megohmeter was attached to the two moisture meter pins. Resistance and voltage drop were measured using the AEMC and Fluka systems, respectively, as 100, 250, 500, or 1,000 V were passed through the pole section. Each specimen was tested at four equidistant points around the pole for each sample.

The moisture meter pins at each location were then used to measure moisture content. Independent moisture meter measurements were made using a Delmhorst Model RDM-25 moisture meter equipped with 37-mm-long pins.

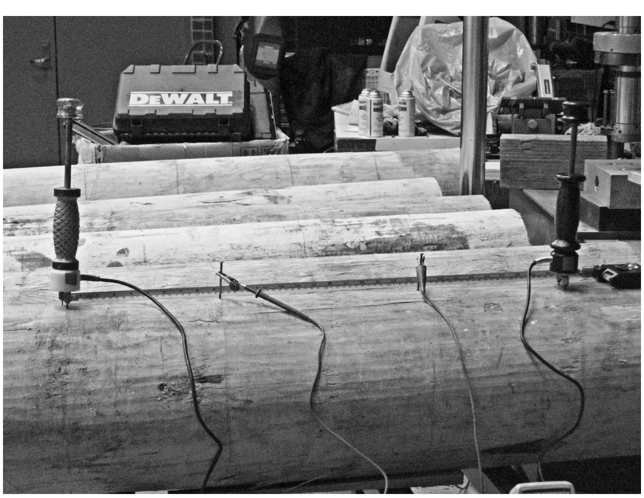

Figure 1.—Locations of moisture meter pins and nails used to measure conductivity and resistance, respectively, in Douglas-fir pole sections treated with pentachlorophenol or copper naphthenate or left untreated.

The tests were run two times: the first shortly after the poles had been treated, and the second 3 months later to determine if weathering and additional exposure to wetting and drying had affected the readings.

Results and Discussion

First measurements

Moisture measurements of the nontreated pole sections ranged from 33 to 45 percent shortly after treatment, while penta-treated sections ranged from 18 to 25 percent and copper naphthenate–treated sections ranged from 15 to 21 percent (Fig. 2). Lower moisture contents for the oil-treated sections could reflect the water repellency afforded by the treatment as well as the drying that occurred within the treatment process. These readings should be viewed as relative, owing to the potential for the oil and preservative to affect meter behavior.

Electrical resistance of nontreated pole sections tended to be very small and uniform across the four applied voltages and there was little variation among the six pole sections at the start of the test (Fig. 2). Resistance also tended to vary little with applied dosage in penta-treated pole sections, but there was more variation in resistance between individual sections. This variation likely reflected differences in preservative and oil loading. Resistance tended to vary little with applied voltage for a given copper naphthenate–treated pole section; however, there was considerable variation in resistance between the 10 test poles. Resistance ranged from 6 to more than 35 MΩ with copper naphthenate, while resistance readings were all less than 2.5 MΩ for penta-treated or nontreated poles. The reasons for the increased resistance of copper naphthenate–treated poles are unclear; however, improvements in the basic insulating properties of the wood could have positive benefits.

Second measurements

Moisture contents of penta- and copper naphthenate–treated pole sections became more uniform over the 3-month outdoor exposure, but the untreated poles remained wet (Fig. 3). Electrical resistance remained low for both the

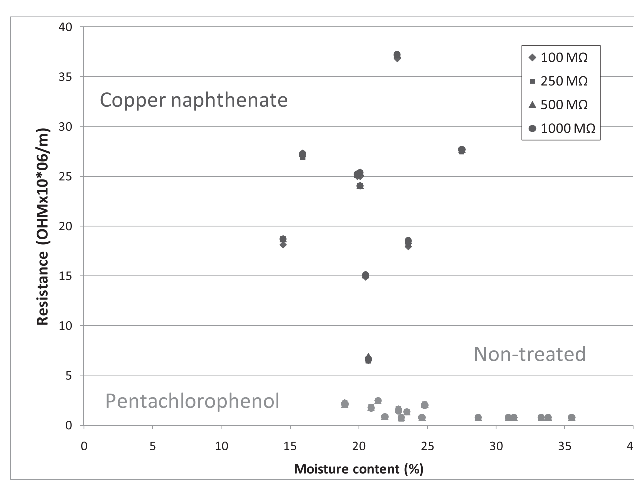

Figure 2.—Moisture contents of Douglas-fir poles versus electrical resistance measured shortly after treatment with copper naphthenate or pentachlorophenol or left untreated.

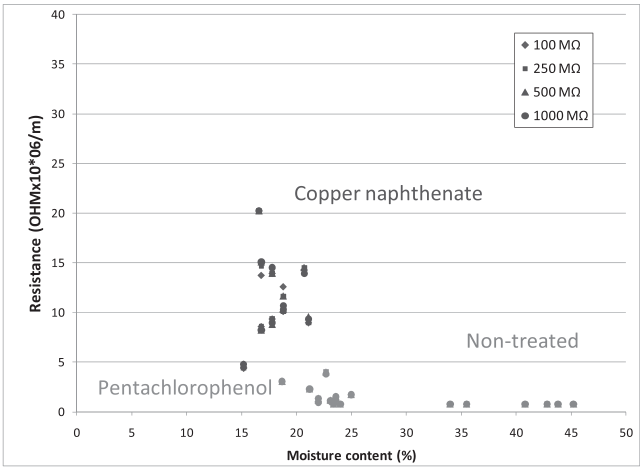

Figure 3.—Moisture contents of Douglas-fir poles versus electrical resistance measured 3 months after treatment with copper naphthenate or pentachlorophenol or left untreated.

nontreated and penta-treated pole sections. Resistance in copper naphthenate–treated poles declined between the two tests, although it was still higher than either of the other two treatments. Resistance in copper naphthenate–treated pole sections was still more variable than in the nontreated or penta-treated sections, but the results indicate that copper naphthenate treatment did not increase conductivity of the wood.

Conclusions

Electrical resistance was similar in wet nontreated and penta-treated Douglas-fir pole sections, while it was much lower in copper naphthenate–treated sections. Resistance was unchanged in nontreated and penta poles after 3 months of outdoor exposure but dropped slightly in poles treated with copper naphthenate. The results indicate that poles treated with copper naphthenate do not pose a conductivity risk.

Literature Cited

American Wood Protection Association (AWPA). 2009. Use category system: User specification for treated wood. Standard U1. *In:* AWPA Book of Standards. AWPA, Birmingham, Alabama. pp. 5–71.

Clark, L. L. and R. Donaldson. 1969. Electrical conductivity of three treated pole timbers. *Electr. Eng.* 46(5):38–51.

Darvenza, M., G. J. Limbourn, and S. A. Prentice. 1967. Line design and electrical properties of wood. *IEEE Trans. Power Apparatus Syst.* 86(11):1344–1355.

Evans, F. G. and B. Nossen. 1989. The variation of electrical resistance in the CCA treated wood during fixation. IRG/WP/3554. International Research Group on Wood Preservation, Stockholm. 6 pp.

Evans, F. G. and B. Nossen. 1991. The relationship between electrical resistance and fixation of waterborne CCA salts in pressure-treated wood. IRG/WP/3657. International Research Group on Wood Preservation, Stockholm. 11 pp.

Homan, W. J. and B. W. Holleboom. 1998. The effect of wood preservatives on the relation between the electric resistance and moisture content in Scots pine (*Pinus sylvestris* L). IRG/WP/98-20142. International Research Group on Wood Preservation, Stockholm. 8 pp.

Katz, A. R. and D. G. Miller. 1963. Effects of some preservatives on the electrical resistance of red pine. *Proc. Am. Wood Preserv. Assoc.* 59: 204–217.

McIntyre, C. R. and R. F. Fox. 1990. Update on Wolman ET™: A new CCA/oil treating system. *Proc. Am. Wood Preserv. Assoc.* 86:63–77.

Morris, P. I. and D. J. Dickinson. 1984. The effect of moisture content on the electrical resistance of timber as detected by a pulsed current resistance meter (Shigometer). IRG/WP/2212. International Research Group on Wood Preservation, Stockholm. 11 pp.

Stewart, P. B. 1936. The electrical resistance of wood poles. *Proc. Am. Wood Preserv. Assoc.* 32:353–385.