UPDATE ON WOLMAN ET™
A NEW CCA/OIL TREATING SYSTEM

Craig R. McIntyre, Ph.D.*
Roger F. Fox**

Abstract

Hickson Corporation has developed a CCA/oil emulsion treating system, "Wolman ET™," that has all the benefits of regular CCA-C, but also dramatically improves the climbability of utility poles. Approximately 2000 utility poles were processed during a commercial plant trial at Koppers Industries and these poles are being distributed to numerous utility companies for use. Climbing evaluations made by linemen have shown improved climbing properties of CCA/oil poles compared to controls. Six-month and one-year climbing evaluations as well as results of strength, corrosion, conductivity, migration, fixation and preservative testing of CCA/oil poles will be discussed.

INTRODUCTION

The preservative known as chromated copper arsenate (CCA) has proven to be the most durable and effective wood treatment available for protection against decay and insect attack. Its durability is related to the unique fixation reactions which occur in wood to produce insoluble compounds that are essentially non-leaching.

The major market for CCA treatment is the residential market and most of the treated lumber is used for fences, decks, and other backyard projects. However, CCA has also been used to treat poles for the utility industry for many years and its usage has been steadily increasing.

CCA TREATED UTILITY POLES

There are approximately 2.8 million distribution poles treated annually in the United States. Of these, 65% are treated with pentachlorophenol in oil, 20% treated with creosote, and 15% treated with CCA. The usage of CCA has been increasing, but at a slow rate.

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* Manager, Research and Product Development Department, Hickson Corporation, Box 607, Orrville, Ohio 44667 USA.
** Manager, Applications Development Section, Hickson Corporation, Box 607, Orrville, Ohio 44667 USA.

Resistance to the use of CCA poles has primarily been due to perceived differences in four properties between the CCA pole and the traditional oil-penta pole. These properties have been studied extensively and three of the differences have been shown to be nonexistent or unimportant in the installation and maintenance of utility poles:

1) Conductivity was presumed to be higher for CCA poles than for poles treated with an oil system, but studies showed conclusively that there is no difference in conductivity between CCA-oxide and oil treated poles.[3,7]

2) Corrosion of hardware was thought to be a problem with a dry CCA pole compared to an oil treated pole, but laboratory studies[1] and millions of poles in service have substantiated the low corrosion potential of CCA-oxides.

3) The brittleness of CCA poles compared to an oil-penta pole was a third area of concern,[8] but many utilities now use CCA poles extensively and have learned to avoid any problems related to impact resistance.

4) Hardness is the last difference associated with CCA poles, but, again, many utilities are successfully using CCA poles. Proper training programs for linemen and good gaff maintenance programs have decreased hardness complaints and the problem has been addressed in various ways. Wolman Researchers have even developed a new gaff design in cooperation with a gaff manufacturer specifically for climbing CCA poles.[5] Still, linemen like the climbability of "oil" poles and resist climbing CCA.

CCA AND OIL

Obviously, there would be distinct advantages in combining the superior preservative properties of CCA with a lubricating oil. Historically, the only way to accomplish this was to treat a pole twice: first with CCA and then, after drying, by an oil. A dual treatment approach was necessary because CCA and oil are incompatible, but this expensive approach significantly lowers the capacity of a treating plant as well as increases the handling costs.

Initial work to overcome this incompatibility was done in Hickson's United Kingdom labs some 20 years ago.[2] The researchers combined oils and waxes with CCA by using emulsion technology. More recently, Australian researchers investigated emulsion technologies: both with creosote and CCA preservative systems.[6,4]

EMULSIFIED TREATMENT

Following their lead, Wolman researchers found that certain blends of surfactants, dispersants, defoamers and additives could successfully be incorporated into CCA and provide commercially usable emulsions (Wolman ET). These emulsions are stable, non-reactive and usable for many days after preparation.

Basically, Wolman ET is an oil-in-water emulsion in which the preservative (CCA-C oxide) is dissolved in the aqueous phase. The oil phase consists of a heavy, lubricating oil dispersed with appropriate surfactants, stabilizers, etc. to provide a stable, non-sludging treatment that incorporates the advantages of both CCA and oil. This technology specifically addresses the hardness or climbability issue.

WOLMAN ET POLE CLIMBING RESULTS

Hickson Climbing Trials

Extensive climbing tests have been conducted with linemen from six different utilities at the Hickson development center in Orrville, Ohio, and the plant in Conley, Georgia. The tests included full-size, commercially treated Wolman ET poles, as well as 12-ft. pole stubs treated in a pilot plant cylinder. Oil-penta poles and regular CCA poles were included as controls. Linemen did not know any details of the treatments other than the obviousness of the oil-penta treatments.

Linemen were interviewed after climbing and asked to rank the poles from 1 to 10 in eight different categories, such as penetration, climbability, degree of comfort, safety, etc. The scores were totalled to determine the average overall preference of linemen.

Over 80% of the time, the linemen ranked the emulsified oil treated poles in the top half of all poles climbed with respect to their overall ability to work on them. This included activities such as drilling and driving lag bolts.

Our results can also be ranked numerically according to how the linemen rated poles for climbability only. Out of a top score of 10, an emulsified oil treated pole achieved a rating of 7.1. The oil-penta poles, on the other hand, had a rating of 6.4; CCA and untreated (but kiln-dried) poles ranked considerably lower.

Probably the most objective and meaningful rating of climbability was made by measuring the actual gaff penetration of the climbers for each of the different types of poles. The average gaff penetration of a CCA/oil treated pole was about 0.9 inch during our climbing trials. Oil-penta gaff penetrations were just above 0.75 inch, while the CCA poles averaged 0.5 inch. This

documents the improvement in pole climbability with the emulsified oil treatments perhaps better than anything else.

In addition to the test results noted above, smaller climbing trials with linemen from various utilities have been conducted. Some of these trials were done when the poles were newly treated and installed, some after six months, and others after one year of exposure. The results of these trials were similar to the previous tests in that the linemen preferred the CCA/oil poles over the CCA and oil-penta treated poles.

Philadelphia Electric Climbing Trial

The Wolman ET poles were also evaluated by the Philadelphia Electric Company. In this trial the linemen rated the poles using climbing and workability criteria similar to that used in previous tests. Linemen rated Wolman ET poles almost equal to oil-penta poles that are currently purchased and better than regular CCA.[9]

1000 Pole Climbing Trial

Currently, we are involved with a large treater and a large utility in a pole climbing survey involving 1,000 CCA and CCA/oil treated utility poles. These poles are being installed in five of the utilityyy's operating companies. Linemen have been instructed to evaluate these poles for climbability and workability based on their pole climbing experience. Shipment of these test poles is ongoing and evaluation forms from linemen are now being received. Results will be tabulated later in the year.

STRENGTH TESTS

Laboratory Tests

Static bending tests using ASTM specifications were conducted on twenty-five 1.5 x 1.5 x 23 inch end-matched southern yellow pine samples treated with CCA, Wolman ET at two oil levels, oil-penta and untreated controls.

In general, all samples showed excellent strength properties, with good performance values in MOE, MOR, and work to maximum load. Summarized results indicate slightly lower average strength values for the Wolman ET samples compared to the other treatments, but, surprisingly, the CCA samples did not show the usual 5-10% loss in this test.

STRENGTH TESTS

21 inch span - single point load at 12% MC - SYPine

		MOE x 10^{-6} (psi)	MOR (psi)	WML (in-lb/in^3)
Untreated	Avg	1.83	13,530	11.9
CCA	Avg	1.83	13,596	11.5
CCA/Oil (1 pcf)	Avg	1.74	12,504	10.7
CCA/Oil (2 pcf)	Avg	1.76	12,212	10.9
Oil-Penta	Avg	1.85	14,028	12.0

Full Size Pole Test

Full size strength tests were also conducted in cooperation with Philadelphia Electric Company. Five CCA and five Wolman ET (Class 5/40 ft) poles were tested for bending strength using the cantilever type method. Each pole was laid on skid boards on the ground and the butt of the pole was clamped in a test jig. A cable was then attached to the tip of the pole and pulled with a winch until failure. Load and deflection readings were recorded incrementally during each test.

Results of the test show the average fiber stress values for the CCA poles to be 10,386 psi at 19.9 moisture content, while the Wolman ET poles averaged 8110 psi at 27.5 moisture content. The differing moisture contents are due to rain for several days prior to the test and some poles being very wet. If the ET strength values are adjusted to 20 per cent, then the test values are comparable at 11,280 for ET and 10,386 for the CCA. These test values are well over the ANSI design stresses for kiln dried southern yellow pine poles.

CONDUCTIVITY

The conductivity of a Wolman ET pole was evaluated by measuring the resistance between two points of the pole with a 500 volt insulated meggar. As in other studies, it was found that the moisture content of the pole had the most impact on conductivity and no difference in conductivity was detectable between the Wolman ET, CCA or oil-penta treated poles.

PERMANENCE (Fixation)

Perhaps the greatest attribute of CCA preservatives is that the chemicals react with wood components and for all practical purposes become permanently affixed in the wood. The importance of this reaction cannot be overstressed since the fixation gives CCA preservatives the service durability of 40+ years.

A major concern in the development of the CCA/oil system was that the oil and surfactant components would interfere with the fixation reaction rate or the completeness of the fixation reaction. If either occurred, then the permanence of the CCA preservative could be impaired and the service life shortened.

Fixation Rate

To answer the fixation rate question, blocks were treated with normal CCA and CCA/oil using two different types of oil. At appropriate intervals, a number of blocks were selected, placed in a hydraulic press, squeezed and the exudate then analyzed. The amount of chromium (VI) at the various times can be used to determine the rate constants. For CCA alone, the apparent second order rate constant was 1.2 1/mole-hr for chromium reduction. For Wolman ET the rate constant was 1.8 1/mole-hr, while for a CCA/oil made with No. 2 fuel oil, the rate constant was 2.3 1/mole-hr. For practical purposes, these values are essentially the same.

Leachability

The completeness of fixation can be addressed by conducting leaching tests on treated blocks, since any untreated components will be extracted from the wood. After treatment, the blocks were dried and then ground into sawdust. The sawdust was subjected to the EP Tox leaching protocol and as shown below, there was essentially no difference in the treatments.

Sample	Leachate, ppm		
	Cr	Cu	As
CCA	7	3	8
Wolman ET	3	2	5

BIOCIDAL TESTING

As further evidence that the fixation reactions are unchanged, various biocidal testing has been performed to compare the Wolman ET with CCA-C oxide preservative. As part of the tests, the ratio of CCA to oil was varied and some samples included only oil or surfactants. To simplify, retentions are given in two parts: the first being the value for CCA-C and the second for the oil-surfactant blend or "ET" portion. Thus, a "0.24, 0.0" contains CCA-C and no oil, while a "0.24, 1.0" contains an equal amount of CCA-C plus 1.0 pcf of oil-surfactant.

Soil Block Test

Soil block testing (ASTM D1413-76) was conducted by Michigan Technological University researchers using four test organisms and varying retentions. For the copper tolerant fungi, Poria placenta, essentially no attack was found for either the Wolman ET or CCA-C blocks at CCA retentions from 0.25 to 1.2 pcf. The untreated controls and the blocks treated with only the oil-surfactant blend did show heavy attack which indicates healthy cultures.

Soil block tests were also done using Gloeophyllum trabeum, Lentinus lepideus and Coriolus versicolor as the test organisms. The Wolman ET and the CCA-C treated blocks, leached and unleached, showed no evidence of degradation (i.e., no weight loss). Untreated control blocks averaged weight losses of 46.8, 32.6 and 16.5% for the three organisms, respectively, which indicated healthy cultures.

Fungal Cellar Tests

Fungal cellar tests according to the proposed AWPA Standard Method are ongoing at Michigan Technological University.

The results through 9 months show significant attack only on untreated controls, stakes treated with the oil-surfactant blend only, and stakes treated with only the surfactants at a level representative of the Wolman ET treatments. In the unleached series, the lowest retention of CCA-C alone (0.10 pcf) had slight attack with an average rating of 9. All CCA-C alone and Wolman ET at higher retentions were essentially without attack.

Stake Tests

Stake tests using 3/4-inch southern yellow pine saplings are ongoing at the Hickson Corporation plot in Gainesville, Florida, to demonstrate the performance of Wolman ET treated wood against decay and termites. The stakes installed in June of 1988 were recently inspected after one year of exposure.

Although the stake data is very preliminary, there do not appear to be any anomalies in the data. As expected, the untreated samples have heavy termite attack and there is slight attack on the extremely low retention CCA and Wolman ET samples; the Wolman ET stakes treated without any CCA are showing some attack at the lower oil levels and it is interesting to note that these samples are performing considerably better than the untreated controls.

3/4-INCH STAKE TESTS

Retention (pcf) CCA-C	Retention (pcf) ET	Rating (12-month)
0.04	0.0	84
0.04	1.0	94
0.04	2.0	96
0.04	4.0	99
0.07	0.0	95
0.09	1.0	99
0.07	2.0	100
0.08	4.0	100
0.18	0.0	97
0.18	1.0	100
0.16	2.0	100
0.20	4.0	100
0.26	0.0	99
0.26	1.0	100
0.23	2.0	100
0.29	4.0	100
0.40	0.0	100
0.36	1.0	100
0.30	2.0	100
0.37	4.0	100
0.60	0.0	100
0.60	1.0	100
0.48	2.0	100
0.59	4.0	100
-0-	0.5	76
-0-	1.0	85
--0-	2.0	96
-0-	2.8	96
-0-	4.0	97

Pentachlorophenol in P-9 Oil

0.20	99
0.31	100
0.42	100
0.52	100

Untreated Controls 28

MIGRATION

Pole sections treated with Wolman ET are being monitored for oil migration. Several pole sections have been vertically suspended and wafers were taken from both the top and bottom of the pole sections after 1, 6, and 12 months exposure to determine oil levels. After 12 months there are no signs of oil migration.

It should be noted that the "oil" used in ET is a high-viscosity, lubricating type oil and minimal migration is expected. In contrast, penta is usually dissolved in a low viscosity, relatively volatile fuel oil.

CORROSION

Corrosion tests were conducted in accordance with military and ASTM specifications on five different metals in contact with untreated, CCA, Wolman ET (at different levels of oil) and oil-penta treated wood. In these tests the aluminum, stainless steel, galvanized and red brass coupons had corrosion rates of <1 mpy when in contact with all treatments. The carbon steel coupons had corrosion rates of <1 mpy in contact with untreated and oil-penta treated samples. The CCA and Wolman ET treated samples had corrosion rates between 3-4 mpy.

Based on the corrosion rates and visual appearance of the coupons tested, there is no difference in the amount of corrosion between CCA and the Wolman ET treated wood. In fact, the corrosion on all tested coupons was minimal and the treatments do not present a corrosion hazard to the different metals.

PLANT TRIALS

Based on these results, a full-scale plant trial was conducted during early 1988 in which over 2000 poles were individually numbered and tracked as they were dried and treated.[10] The treatment was relatively uneventful and no problems with foaming, oily surfaces or preparation were encountered. Every pole was bored after treatment to measure penetration and each charge was inspected by independent inspectors. All charges passed normal quality control requirements and the poles were stacked for shipment.

These poles are being installed by a number of utilities and, where possible, reports on climbing are being obtained, such as the 1000 pole survey previously mentioned. To date, the reports are very favorable to Wolman ET.

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