Bull. Environ. Contam. Toxicol. (1986) 37:467–474
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Bulletin of Environmental Contamination and Toxicology

# Effectiveness of Candidate Barrier Sprays for Managing Residues of Chlordane on Plywood

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Treatment of soil under homes with termiticides is a common practice to protect structures from termite damage. Chlordane is currently the major insecticide used for this purpose. Because of concerns for the human health effects of chlordane, OSHA adopted an occupational permissible exposure limit (threshold limit value) of 500 ug chlordane/$m^3$ of air (USHEW 1978). Subsequently, an expert committee of the National Academy of Science (NAS) proposed interim guidelines of 5 ug/$m^3$ of air for continuous long-term exposure of inhabitants to airborne chlordane (NAS 1982). Results of a recent study suggest that houses treated with chlordane for control of termites according to label directions contain concentrations of chlordane within guidelines recommended by NAS (Leidy et al. 1985). Although the recommended application is strictly a soil treatment, chlordane residues have been detected in air samplings of homes following treatment (Malina et al. 1959, Stumphy and Atallah 1975, Cahill 1979, Cahill and Jimenez 1982, Wright and Leidy 1982). In some cases, these residues are caused by accidents, misapplications or carelessness. There is wide interest in methods or techniques to reduce chlordane residue in residences, especially following accidents or misapplications. The current study was designed to test the effectiveness of selected paints in reducing surface residues and evaporation of chlordane from treated wood surfaces.

## MATERIALS AND METHODS

Technical chlordane in an EC formulation of 8 lbs./gal. (Velsicol Chemical Corp.) was diluted to a 1% concentration in water and sprayed onto plywood panels at a rate of 350 ug/100 $cm^2$ of surface area. Exactly 0.93 ml of the concentrate was mixed with 1892 ml of water in a one gal. B & G sprayer equipped with a flat fan spray nozzle. Seven grams of the tank mixture was sprayed evenly over the upper surface of each plywood panel (30.5 X 30.5 cm) while the panel was positioned on a tared triple beam balance. Replicate samples of tank mix were collected at the nozzle tip between panel treatments for application control determinations. Based on results of analyses of these samples, 3.3 ± 0.1 (1 SD) mg of chlordane was applied to each panel. The first coat of each candidate barrier was sprayed over the treated surface at 48 h. after application of chlordane. Any additional coats of barrier material were spray applied at 24 h. intervals. K-20 was supplied as components A (includes potassium silicate) and B (borate catalyst) and were mixed in a 10:1 (A:B) ratio <10 minutes before application to panels. Sources and approximate amounts of candidate barrier materials used in these experiments are listed in Table 1.

Table 1. Candidate barrier materials used in air and contact tests with chlordane on plywood.

| Candidate Barrier | Brand/Source | Gm.AI/Appl. /100 $cm^2$ |
|---|---|---|
| Enamel[2] | Sears High Gloss | 0.32 |
| Epoxy[2] | N.Y. Bronze Powder Co. | 0.18 |
| K-20[1] | Lopat Enterprises | 1.40 |
| Latex[2] | Gilman Acry-Lite Latex | 0.06 |
| Polyurethane[2] | Sears Hearth Varnish | 0.20 |
| Silicon Sealer[1] | Thompson's Water Seal | 0.45 |
| Sodium Silicate[1] | Fisher Scientific Co. | 0.67 |

[1] Laboratory aerosol sprayer
[2] Commercial pressure spray container

Panels were air sampled for 15 h. at a rate of 2 L/min. at post-treatment intervals of 4, 15, 30 and 90 days. Flow rates of air were maintained with programmable vacuum pumps (Model HFS 113A, Gilian Corp., Wayne, NJ or Model HFS 113, SKC, Inc., Eighty Four, PA) that were calibrated previously with a mass flow meter. Chlordane in air samples was collected onto polyurethane foam (80 X 11 X 10cm) in a glass tube (80 X 10 cm ID) attached to a glass funnel (100 mm diameter ID) which was inverted and suspended 2 mm from the surface of each test panel (Atallah 1982). Exposed foam was extracted into 5 ml of hexane (nanograde hexanes, Mallinkrodt). Contact samples were taken at 4 and 90 days post-treatment by wiping a cotton ball slightly less than saturated with hexane over a 100 $cm^2$ area of each test panel. Chlordane on cotton wipes was extracted into 10 ml of hexane. All hexane extracts were acid washed to remove substances which could interfere with analyses. Two ml of each extract were mixed with one ml of concentrated sulfuric acid. At 30-45 seconds, the acid layer was removed and approx. 100 mg of a 9:1 mixture of sodium sulfate (Fisher) and sodium carbonate (Baker AR) were mixed with the hexane extract.

The six major components of chlordane analyzed in this study were compound C, heptachlor, compound E, trans-chlordane, cis-chlordane and trans-nonachlor. Each component was quantitated with a Tracor 550 gas chromatograph equipped with an electron capture detector and according to procedures in Velsicol AM-0767 (Velsicol 1983). Five ul of each sample extract was injected onto a glass column (0.2 cm ID X 180 cm) packed with 3% SE 30 on Gas Chrom Q, 100-120 mesh. A flow rate of 35 mL/min. of $N_2$ was maintained through the column at an oven temperature of $180^oC$. Each component of chlordane was quantitated with a reporting integrator (Hewlett-Packard, Model 3390A) by comparison with analytical standards by linear regression analyses. Values reported as chlordane are sums of the six components.

## RESULTS AND DISCUSSION

In tests without candidate barriers, chlordane (sum of six components) in air samples decreased rapidly with time after treatment (Table 2). At 90 days post-treatment, chlordane levels were only 12% of those at four days post-treatment (Table 2). In tests with surface (contact) samples, chlordane levels remained about constant during the test period and were quite low relative to levels in air samples (Table 2). Each of the six components of chlordane behaved similarly to chlordane in air (Fig. 1A,B,C) and contact (Fig. 2) tests.

Most of the candidate barrier materials reduced levels of chlordane (Table 2) and each component (Fig. 1A,B,C) in air samples at each of four sampling times post-treatment. At 90 days after treatment, (Table 2, and Fig.1C), concentrations of chlordane in air samplings of panels treated with silicone sealer and latex paint were no less than that from chlordane control (no barrier) panels. Air levels of chlordane were about equal in tests with sodium silicate, K-20, enamel, and polyurethane treatments and were considerably less than that of control (no barrier) chlordane treatments at 90 days after treatment. Epoxy paint was the most effective barrier at 90 days post-treatment. In general, air concentration of chlordane in combination with each of the barrier materials was less than that in controls, but parallelled the decrease of chlordane with time in chlordane control (no barrier) panels.

Relative effectiveness of candidate barrier materials as

Table 2. Comparative effectiveness of two coats of each indicated candidate barrier on chlordane residue in air and contact samples.

| | Percent of Control (No Barrier) Chlordane at Indicated Days After Treatment of Panels | | | | | |
|---|---|---|---|---|---|---|
| | 4 | | 15 | 30 | 90 | |
| | air | contact | air | air | air | contact |
| Polyurethane | - | 52 | 32 | 26 | 32 | 57 |
| Latex | 16 | 150 | 83 | 73 | 106 | 190 |
| Enamel (OB) | 9 | 33 | 75 | 33 | 50 | 23 |
| Silicone Sealer | 7 | 91 | 67 | 71 | 122 | 80 |
| Epoxy | 12 | 168 | 42 | 49 | 10 | 10 |
| K-20 | 22 | 96 | 14 | 93 | 46 | 10 |
| Sodium Silicate | 19 | 29 | 21 | 42 | 37 | 11 |
| No Barrier[2] | 10434 | 400 | 3820 | 2772 | 1246 | 742 |

[1] Each data point is an average of 4 replications

[2] Data for the positive control (no barriers) are expressed as ng chlordane residue/100cm$^2$ (as air or surface-contact residue)

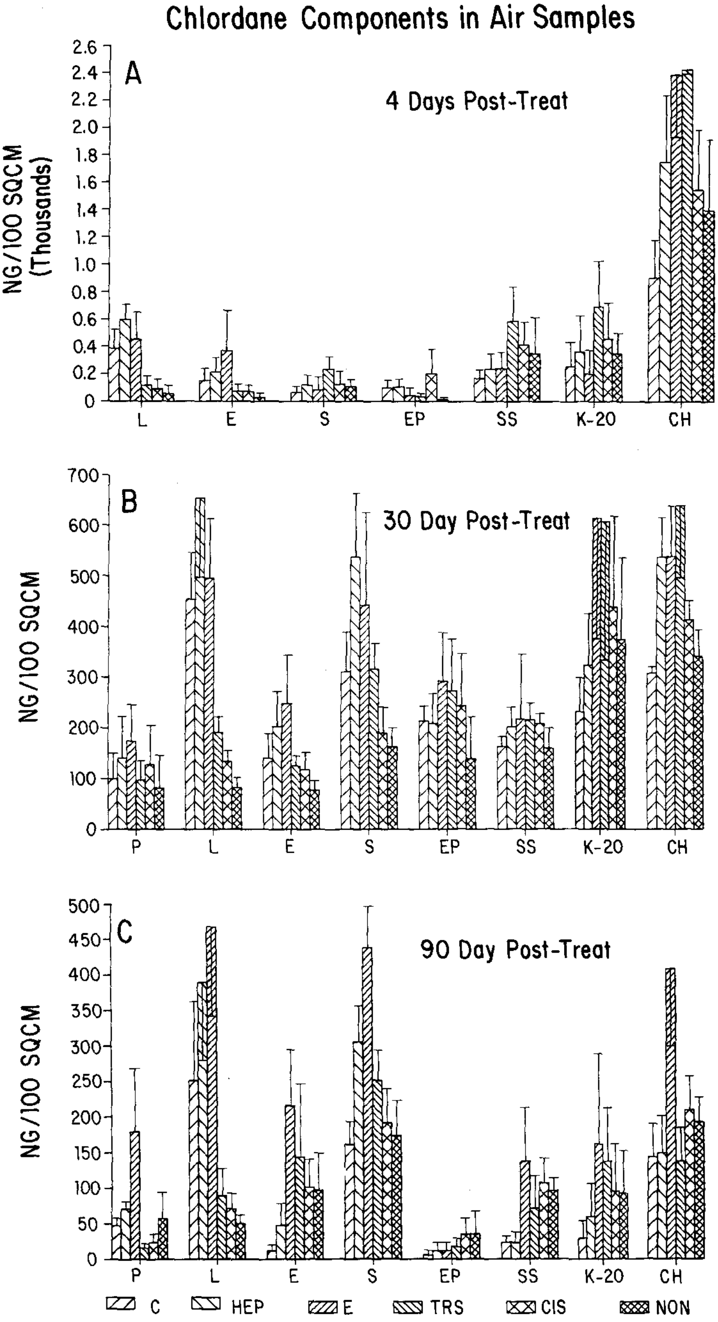

Figure 1 Chlordane components + SE in air samples from plywood treated with the following candidate barriers: P = polyurethane, L = latex, E = enamel, S = silicone sealer (oil-base), EP = epoxy, SS = sodium silicate, K-20 = K-20 formulation, CH = Chlordane (no barrier). Chlordane components: C = compound C, HEP = heptachlor, E = compound E, TRS = trans-chlordane, CIS = cis-chlordane, NON = trans-nonachlor.

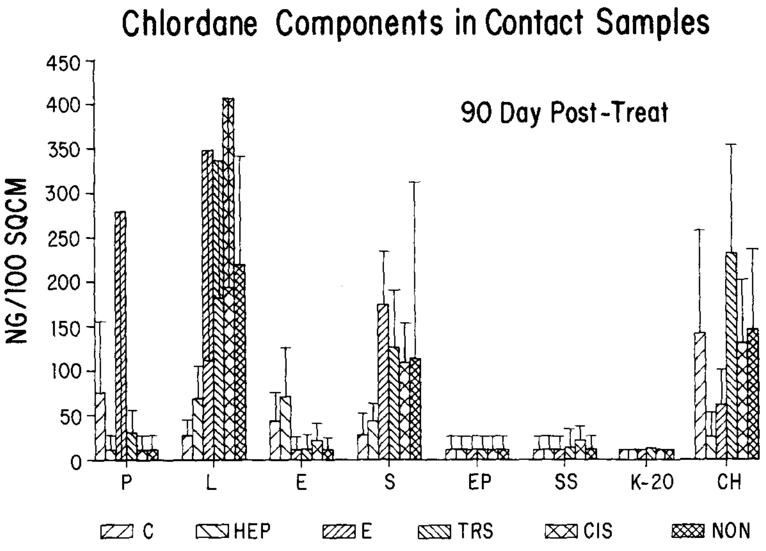

Figure 2 Chlordane components in contact (wipe) samples from plywood treated with candidate barriers as described in Figure 1.

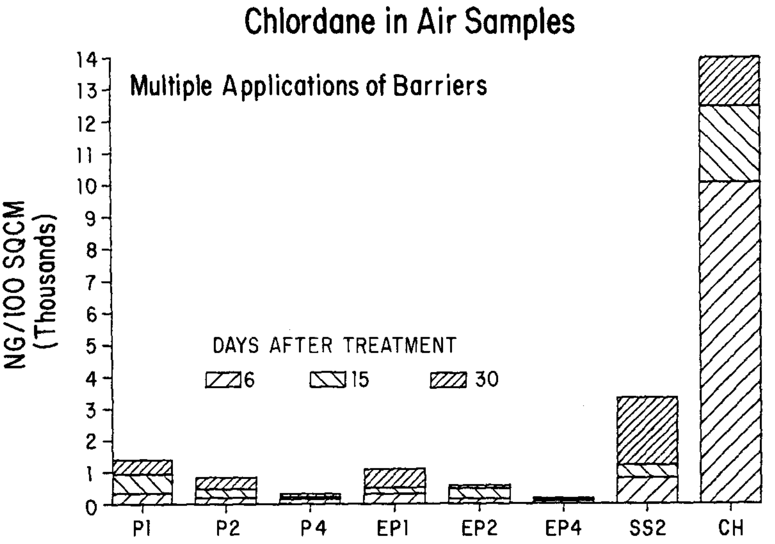

Figure 3 Chlordane (expressed as the sum of the six components) in air samples at the indicated days after treatment with multiple coats of candidate barrier: P1, P2, P4 = polyurethane, 1, 2, 4 coats; EP 1, EP2, EP4 = epoxy, 1, 2, 4 coats; SS2 = sodium silicate, 2 coats; CH = chlordane, no barrier.

contact protectants is shown in Table 2 and Fig. 2. Sodium silicate was most effective and most consistent in reducing levels of chlordane on panels. Enamel paint and K-20 were more effective than polyurethane. Epoxy, silicone sealer and latex paint were least competent as a contact barrier at four days post-treatment (Table 2). Chlordane in air samples at 90 days (Table 2, and Fig. 1C) and in contact samples at 4 (Table 2) and 90 (Table 2, Fig. 2) days post-treatment from latex test panels actually exceeded that from panels treated with chlordane alone (no barrier) at both intervals tested. Results obtained with latex in this study are consistent with known slow release properties of latex (C.M. Himel, personal communication). Silicone sealer (oil base) was only slightly more effective than latex. K-20 and epoxy treatments were increasingly effective with time and compared favorably with sodium silicate at 90 days post-treatment.

Behavior of each of the six components of chlordane generally was similar to that of the sum of the components within tests with each candidate barrier. In tests on each component in air samples (Fig. 1A,B,C), variations observed were without a pattern. High levels of compound E especially at 90 days post-treatment was an exception (Fig. 1A). With contact samples, levels of compound E also were more variable than other components (Fig. 2). Heptachlor component, an effective termiticide, behaved about the same as chlordane (6 components) with each candidate barrier in air (Figs. 1A,B,C) and contact (Fig. 2) tests.

Polyurethane and epoxy were selected for multiple application tests because of their overall favorable performance in the previous experiment. With both polyurethane and epoxy paints, reduction of chlordane levels in air samples correlated positively with the number of coats of barrier material applied (Fig. 3). In agreement with results of the previous experiment, epoxy paint was only slightly more effective than polyurethane paint. Compared with no barrier controls, both materials reduced significantly the amount of each component of chlordane in air samples. Sodium silicate, although not as effective as polyurethane and epoxy in air sampling tests, was clearly effective in contact tests in reducing all six components of chlordane (Fig. 3).

Results of preliminary bioassays with the subterranean termite, *Reticulitermes flavipes*, on test panels generally support GLC data on air samples given in Table 2. The chlordane control and chlordane/epoxy treated panels were most and least toxic, respectively, to termites indicating that the candidate barrier effectively reduced availability of chlordane. Bioassay tests are being continued.

Tests are also in progress with candidate barriers on other structural surfaces and with combinations of candidate barriers to determine their value in containing chlordane residues.

Acknowledgements. We thank Ms. Claudia Rhyne for her valuable assistance in conducting these experiments. This research was supported by the University of Georgia Agricultural Experiment Stations and Velsicol Chemical Corporation.

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Received September 5, 1985; accepted February 26, 1986