Development of a Robust Termite-Resistant Foam Insulation

Jeffrey M. Alcott

ABSTRACT

The use of foam insulation in buildings is a very effective way to reduce energy costs. However, using foam insulation on exterior foundations is discouraged or even banned by some building codes in areas with very heavy termite infestation probability. Although the insulation does not provide any nutritional value, the termites can tunnel through the foam in search of food. The resulting termite damage can reduce the overall thermal resistance of the insulation.

This report summaries the development of termite-resistant foam insulation. This work shows that adding the deltamethrin termiticide with its superior insect contact repellency to an extruded polystyrene foam insulation formulation can effectively protect the foam from termites. The effectiveness of this approach was confirmed using a short-term extreme field exposure study and a long-term field performance study conducted in accordance with governmental and industry evaluation protocols.

The short-term study showed that deltamethrin provides significant protection of extruded polystyrene insulation against both R. flavipes and C. formosanus termites. The long-term field performance study showed that extruded polystyrene insulation containing deltamethrin meets all U.S. EPA efficacy requirements and ICC-Evaluation Services (ICC-ES) acceptance criteria for termite-resistant foam plastic. Analytical measurements of the deltamethrin content levels in extruded polystyrene insulation samples retrieved from the long-term field performance study confirmed the presence and stability of the deltamethrin level in extruded polystyrene insulation over time.

INTRODUCTION

The Challenge? Develop a Termite-Resistant Insulation

With escalating energy costs and the growth of green building practices, the building design community, building owners and manufacturers are placing more importance on the use of continuous insulation for greater energy savings. However, in many locations, especially the southern United States, using foundation insulation in contact with the ground is complicated by the presence of termites. Although there are a number of termite prevention methods currently on the market, there is an opportunity to design an insulation product for exterior foundation applications that also addresses termite infestation concerns.

Insulating building foundations is an important step in reducing total energy costs and usage. Foundation energy loss represents approximately 15% of the total energy loss in current U.S. residential construction (Huang 1999). Selecting the correct type of insulation is critical; for exterior below-grade applications, closed-cell foam plastic insulation can provide long-term R-value performance in a harsh, moist environment (Strzepek, et al. 1983). Studies have shown that the payback period for insulating residential concrete slabs and closed crawl spaces can be as short as 5 to 15 years (Carmody, et al. 1991). As the cost of energy continues to rise, the payback period becomes increasingly favorable.

Combating the adverse effects from termite activity is expensive. Despite the continuous improvement of termite control treatments and building codes requiring their use, the

Jeffrey M. Alcott *is Senior Development Specialist with Dow Chemical Company, Midland, MI.*

National Pest Management Association (NPMA) estimates the cost of termite damage and termite control in the U.S. to be about $5 billion annually. As shown in Figure 1, 'very heavy' and 'moderate-to-heavy' termite infestation areas cover a significant portion of the U.S.

Many insulation materials - including foam plastic - provide no food value to termites. However, termites may tunnel through or up behind the insulation on the foundation to reach wood framing and other food sources in a building (Zungoli, et al. 1995). In some cases, the foam may look intact from the exterior, but termites can tunnel through the foam insulation thereby reducing its overall thermal efficiency.

Because of these issues, starting in 1997, the U.S. model code organizations adopted restrictions on the use of foam plastic insulation in 'very heavy' termite infestation areas. Currently, the 2006 edition of the International Code Council (ICC) International Residential Code (IRC) and International Building Code (IBC) contain the following requirement:

Foam Plastic Protection. In areas where probability of termite infestation is "very heavy" as indicated in [see Figure 1.], extruded and expanded polystyrene, polyisocyanurate and other foam plastics shall not be installed on the exterior face or under interior or exterior foundation walls or slab foundations located below-grade. The clearance between foam plastics installed above-grade and exposed earth shall be at least 6 inches.

Exceptions:

1. Buildings where the structural members of walls, floor, ceiling and roofs are entirely of non-combustible materials or pressure preservatively treated wood.
2. When in addition to the requirements of R320.1 [chemical soil treatments, et al.], an approved method of protecting the foam plastic and structure from subterranean termite damage is provided.
3. On the interior side of basement walls.

Energy standards also have responded to the termite issue. The American National Standards Institute (ANSI) / American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) Standard 90.2 Energy-Efficient Design of Low-Residential Buildings and the ICC International Energy Conservation Code (IECC) required foundation insulation in high termite infestation areas until the 2004 and 2006 editions respectively. However, because of a lack of code-approved termite-resistant insulation options, these two model energy codes (ANSI/ASHRAE Standard 90.2 and the IECC) were amended so that no exterior foundation insulation is required in areas of high termite activity.

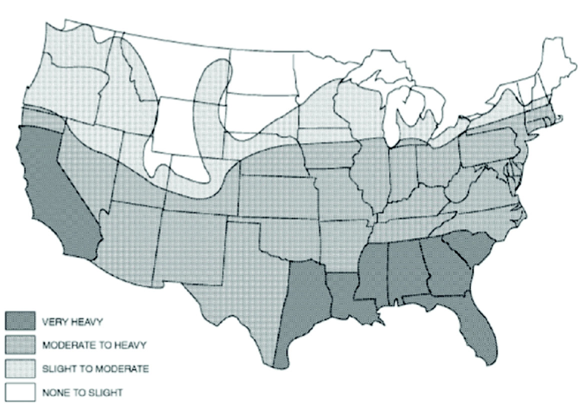

Figure 1 *U.S. termite infestation probability map (courtesy of the International Code Council).*

The challenge is to design an insulation for below-grade applications that is also termite-resistant.

TERMITE-RESISTANT FOAM INSULATION DEVELOPMENT

Design Criteria for a Termite Resistant Insulation

A termite-resistant insulation must meet or exceed the following design criteria:

- Be commercially viable.
- Be effective against termites and maintain this performance long-term.
- Meet industry and government requirements (U.S. EPA, building codes/ICC codes and ASTM standards for foam insulation).

Options/Approach

Attempting to make building materials termite-resistant is not new; many solutions are commercially available. Termite-resistant solutions for foam insulations generally follow four main approaches:

1. **Physical Barrier:** In this approach, the foam or insulation system's physical characteristics must prohibit insects from chewing into or tunneling through the foam. Although there are many termite-resistant materials (e.g. stainless-steel), their use may be impractical because they are a poor insulator, costly, not effective or not suited for the below-grade foundation application.
2. **Insecticide Coating:** Another common approach is to coat the foam insulation with an insecticide. Because the insecticide is typically applied to the exterior surface, with or without pressure-assisted impregnation, it may wash away or dissipate over time. Also to be effective, termites must absorb a lethal dose of the insecticide while chewing into the foam. Over time, some termites will die but there could be significant damage to the foam or coating. A borate-treated expanded polystyrene foam is currently available in the market and has been reported to perform acceptably (Williams et al. 2003).
3. **Insecticide Additive — Reactive Approach:** In this approach, foams are manufactured with an insecticide that will kill termites with sufficient direct exposure. Because termites need to chew into the foam to be effec-

tive, the foam can become significantly damaged over time. Some insecticides also have a high volatility that could cause them to diffuse out of the foam over time.

4. **Insecticide/Repellent Additive—Proactive Approach:** This strategy is relatively new and involves making a foam plastic insulation with an insecticide which also has contact repellency characteristics. The insecticide/repellent in the foam 'repels' the termites on contact. There is no need for termite to chew into the foam to be effected. By adding an insect-repellent to polymeric foam, such as polystyrene foam, termites are deterred from chewing into or tunneling through the foam and the physical properties of the insulation will not be compromised.

Solution

Based on the design criteria and a review of the various termite-resistant approaches, the objective of this study was to develop an extruded polystyrene insulation that has effective and long-term contact repellency toward termites.

Extruded polystyrene insulation was selected for this work because it is ideally suited for building foundation insulation applications – it has a high R-value for thermal efficiency, superior moisture resistance to maintain long-term insulating value and a high compressive strength to withstand construction handling, backfilling abuse and compressive loads from the soil.

A literature review and interviews with termite research experts identified the hyperthyroid family of insecticides as having effective insect repellency characteristics. Pyrethroids are synthetic analogs of pyrethrum, a natural insecticide found in chrysanthemum flowers and are widely used to control insects on agricultural food crops in commercial and residential applications. Studies have shown that they are very effective against a wide range of insects with a relatively low mammalian toxicity (Todd 2003).

Pyrethroids have also been shown to possess very effective contact repellency toward termites (Su, et al. 1982, Su and Scheffrahn 1990). Therefore, a hypothesized robust solution was that a pyrethroid providing contact repellency could be added to the extruded polystyrene insulation to provide long-term termite resistance.

A second literature review, along with further discussions with industry experts and pyrethroid manufacturers, narrowed the choice of pyrethroids from the 1000 plus synthetic pyrethroids available to approximately 10 commercially available practical alternatives. Although pyrethroids as a group have similar insecticidal characteristics, physical properties do vary. The general selection criteria for a pyrethroid for use in foam insulation are shown in Table 1.

Using the key requirements above and information on the commercially available pyrethroid alternatives, deltamethrin (cyano-(3-phenoxyphenyl)-methyl] 3-(2,2-dibromoethenyl)-2,2-dimethyl-cyclopropane-1-carboxylate) was selected for evaluation. As with many pyrethroids, deltamethrin is a very effective termiticide and also has very effective contact repellency properties towards termites. By working as a sodium channel modulator, the deltamethrin causes continual excitation of nerve endings that leads to its contact repellency. Deltamethrin is a solid with effectively no vapor pressure and no water solubility at foam insulation use temperatures so it is not expected to diffuse out, wash off or leach out of a solid plastic over time.

Deltamethrin is also compatible with the pressure, temperature and foaming conditions required to produce an extruded polystyrene insulation. In the manufacturing process, deltamethrin along with polystyrene and other raw materials are fed into a plastics extruder. After the materials are melted, mixed and extruded through a die, the mixture foams and is formed into a foam plastic insulation board. Dispersing the deltamethrin throughout the plastic matrix of the foam, not only provides contact repellency protection throughout the foam insulation structure, but the plastic also protects the deltamethrin from environmental elements that would cause it to degrade over time.

Evaluation Approach

The evaluation of termite-resistant extruded polystyrene insulation containing deltamethrin was conducted in two steps:

Step 1: Concept Evaluation: The purpose of this step was to screen the ability of polystyrene foam containing deltamethrin to resist damage under an extreme exposure to subterranean termites. The two factor experimental design plan is provided in Table 2. A foam specimen containing deltamethrin was bundled together with three spruce wood bait boards and a foam control sample without deltamethrin. Wood applicator sticks were used to provide separation spaces between the foam and wood bait boards in the bundle. These test bundles were placed in underground monitoring stations described by Su and Scheffrahn (1990) located near known termite colonies. Termite species and activity were monitored using wood bait blocks at each test station for two to four years prior to testing. Only monitoring stations found with more than 5000 termites in wood bait blocks at the time of starting the study were chosen for testing.

Step 2: Long-Term Field Performance: The second step of the evaluation process was to complete a long-term field performance study of foam treated with deltamethrin as required for U.S. EPA approval and U.S. building code acceptance. Under U.S. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) regulations, all pesticides are required to be evaluated and approved for each use. The protocol identified in U.S. EPA Product Performance Guidelines for evaluating insecticide treated foam is OPPTS 810.3600 Structural Treatment. This protocol states that modifications of the Stake method are acceptable in evaluating the efficacy of pesticide treatments. The Stake method is described in ASTM D1758 and American Wood Preservative Association (AWPA) E7 evaluation method. In addition, the ICC-ES has established EG239 'Evaluation Guideline for Termite-Resistant Foam

Table 1. Key Pyrethroid Requirements

Efficacy	Foam with pyrethroid must meet termite-resistance requirements
Physical Properties	Must be compatible with foam formulation Must be compatible with manufacturing conditions Must not leach or diffuse out of foam
Governmental Approvals	Must be registered with the U.S. EPA and approved for use to protect foam
Commercially Available	Must be commercially available in North America
Safety	Must be able to be handled and used safely

Table 2. Screening Study Experiment Design Plan

Item	Study Plan
Termite Species	*Reticulitermes flavipes* (Eastern subterranean termite) *Coptotermes formosanus* (Formosan subterranean termite)
Foam Deltamethrin Concentrations (Treatment)	0 ppm (control) 1000 ppm
Test Site Geography	Southeastern Florida. Three separate colonies per species (e.g., 3 colonies of R. *flavipes* and 3 colonies of C. *formosanus*)
Specimen Replicates	6 replicate specimens at each treatment per species (2 monitoring stations at each termite colony. Three colonies of each termite species.)

Plastic' to show compliance to the ICC building codes. Both U.S. EPA and ICC-ES protocols required a minimum 3-year field study at three different geographical sites. To complement the termite-resistance data, it was decided to install extra field samples at each test site and to periodically retrieve and analyze these samples for deltamethrin content to confirm the actual deltamethrin concentration in the foam over time.

A summary of the two factor experimental design plan is provided in Table 3. A diagram of the sample installation is shown in Figure 2. All deltamethrin-containing insulation samples were made by the Dow Chemical Company using existing commercial extruded polystyrene insulation formulations with the addition of deltamethrin. The deltamethrin used in this study was a technical grade from Bayer Environmental Science.

RESULTS

Concept Evaluation

In this screening study, completed by Su, Ban and Scheffrahn (2003), the samples of deltamethrin-containing insulation were evaluated for termite-resistance for up to 4 months until substantial damage from termites was visible in the wood bait blocks in the test bundles. The number of termite tunnel holes was counted and the percent area loss was measured. The study found that the *R. flavipes* species of termites did not tunnel into or damage the surface of foam samples containing 1000 ppm deltamethrin. The study also found that more aggressive *C. formosanus* species of termite caused only insignificant surface damage as shown in Figure 3 with a control foam sample. A tabular summary of results and statistics is provided in Table 4.

Long-Term Field Performance

The long term field performance study was initiated at all three test sites between February and March 2000. Test installation and data collection at the Clayton, NC and Molino, FL test sites were completed by Bayer Environmental Science researchers. Test installation and data collection at the Gulfport, MS test site was completed by Rich Mountain Wood Protection Services. The long term field performance study was formally discontinued at all test sites between April and May of 2005 due in part to Hurricane Katrina damage to the Gulfport, MS test site and area. The five-year exposure period exceeded the minimum three-year field study required in both the U.S. EPA and ICC-ES EG239 evaluation protocols.

Test Site: Clayton, NC: The termite activity at the Clayton, NC test was concluded to be ‘moderate’ based on wood stake inspections that showed an ASTM rating from 4.3-8.3 or approximately 5-50% of surface area damaged by termite holes and tunnels (See Table 5).

A summary of the Clayton, NC data on foam samples with different concentrations of deltamethrin with a statistical analysis of the results for above and below-grade foam section is shown in Figures 4a and 4b.

Table 3. Summary of Experimental Design Plan

Item	Study Plan
Foam Deltamethrin Concentrations (Treatment)	0 ppm (control) 250 ppm 500 ppm 750 ppm 1000 ppm 1500 ppm
Test Site Geography	Three test sites: Clayton, NC Molino, FL Gulfport, MS
Test Period	5 years (Note: U.S. EPA and ICC-ES require 3 year minimum exposure)
Specimen Replicates	10 replicate specimens at each treatment at each test site (Note: Additional sacrificial specimens were included at each test site to be periodically removed and analyzed for actual deltamethrin concentration)
Foam Specimen Size	16 x 7.5 x 1 inch (40.4 x 19 x 2.5 cm)
Specimen Placement	Use a random grid placement pattern with about 3-10 feet (1-3 m) spacing between specimens at each test site
Specimen Position	Bury approximately 25-33% of long dimension of the foam below-grade.
Bait	Attach pine wood bait block 7.5 x 1 x 1 inch (18 x 2.5 x 2.5 cm) to the top of foam boards.
Termite Monitoring Stakes	Insert pine wood stakes 6 x 1.5 x 1.5 inch (15 x 4 x 4 cm) 4 inch (10 cm) away from both sides of each foam specimen with approximately 50% of their length buried in the ground
Specimen Covering	Cover the above-grade portion of foam specimens and wood stakes with white plastic buckets having four 0.25 inch (0.1 cm) diameter vent holes on the upper sides
Specimen Data Collection	Inspect annually all foam specimens to count and record the number of surface holes. Calculate the surface damage using a nominal hole diameter of 0.1 inch (2.6 mm) or 0.007% damaged surface area per hole. Remove foam specimens with 250 ppm and 1500 ppm deltamethrin annually to analyze the below and above-grade sample for deltamethrin concentration
Monitoring Stake Data Collection	Annually, remove and inspect all wood monitoring stakes. Rate the termite damage using the ASTM D1758 / AWPA E7 rating method. Replace all wood stakes with new fresh stakes after rating.

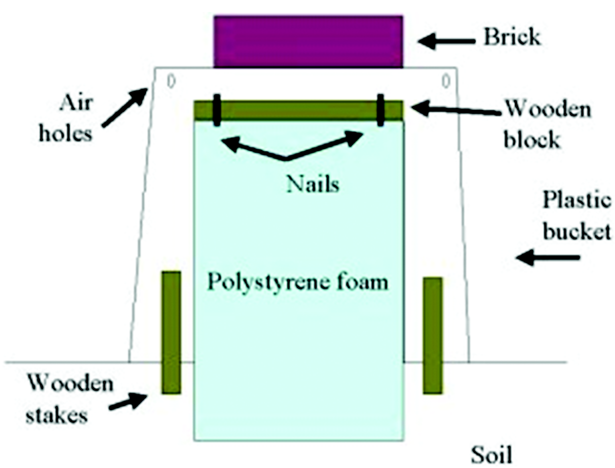

Figure 2 *Sample installation for field performance test Study.*

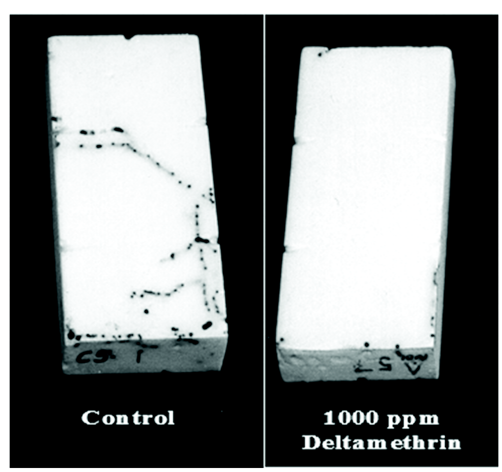

Figure 3 *Visual results from short-term validation study.*

Table 4. Concept Evaluation Data Statistics[1]

Termite Type	Variable	Control Foam (mean ± S.E.)	Foam Treated with 1000 ppm Deltamethrin *(mean ± S.E.)*	F-value	P	df
R. flavipes	Number of holes	51.4 ± 21.1	0.0 ± 0.0	3.01	0.0871	2, 12
	Area excavated	18.8 ± 4.5	0.0 ± 0.0	15.39	0.0005	2, 12
	Percent area loss	9.6 ± 2.3	0.0 ± 0.0	15.39	0.0005	2, 12
C. formosanus	Number of holes	22.7 ± 7.5	0.0 ±0.0	3.3	0.0648	2, 12
	Area excavated	23.5 ± 6.8	2.8 ± 2.7	3.82	0.0455	2, 12
	Percent area loss	12.0 ± 3.5	1.4 ± 1.4	3.82	0.0455	2, 12

[1]Results were subjected to analysis of variance (ANOVA). The difference between the control foam and the foam treated with 1000 ppm deltamethrin are statistically significant (α = 0.05) based on a Fisher least significant difference (LSD) test.

Table 5. Average ASTM Ratings to Stakes and Bait Wood Clayton, NC—2005

Deltamethrin Conc. (Treatment)	ASTM Rating for Monitor stakes			ASTM Rating for Bait Wood
	Stake A	Stake B	Average	
0 ppm	7.6	7.4	7.5	9.0
250 ppm	7.4	7.2	7.3	10
500 ppm	6.1	7.5	6.8	10
750 ppm	4.3	4.8	4.6	10
1000 ppm	6.7	6.9	6.8	10
1500 ppm	8.3	6.3	7.3	10

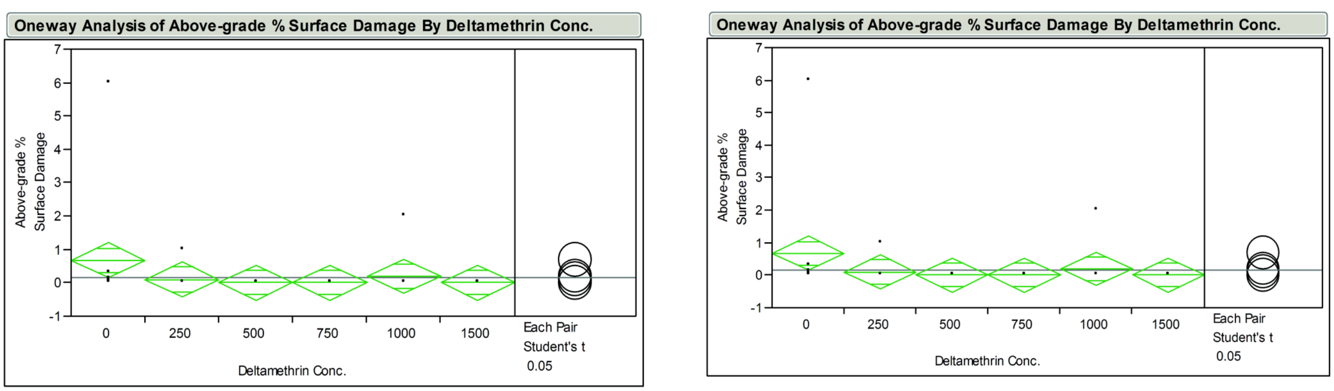

Figure 4 *Clayton, NC statistical analysis below grade[1] (left) and above grade (right).*

1. All statistical analysis was performed using JMP Statistical Discovery software (v6.0) from SAS Institute (typical).

Test Site: Molino, FL: The termite activity at the Molino, FL test site was concluded to be ‘high’ based on wood stake inspections that showed an ASTM ratinfrom 4.4-6.8 or approximately 30-70% of surface area damaged by termite holes and tunnels (See Table 6).

A summary of the Molino, FL data on foam samples with different concentrations of deltamethrin with a statistical analysis of the results for above and below-grade foam section is shown in Figures 5a and 5b.

Test Site: Gulfport, MS: The termite activity at the Gulfport, MS was also considered to be ‘high’ based on wood stake inspections that showed an ASTM rating from 2.3-6.7 or approximately 60-89% of surface area damaged by termite holes and tunnels. (See Table 7).

A summary of the Gulfport, MS data on foam samples with different concentrations of deltamethrin is shown in Figure 6. The foam data reported at the Gulfport test site included only the number of foam specimens that exhibited

Table 6. Average ASTM Ratings to Stakes and Bait Wood Molino, FL—2005

Deltamethrin Conc. (Treatment)	ASTM Rating for Monitor stakes			ASTM Rating for Bait Wood
	Stake A	Stake B	Average	
0 ppm	3.0	5.8	4.4	9.0
250 ppm	5.2	6.0	5.6	10
500 ppm	5.2	6.0	5.6	10
750 ppm	5.7	7.8	6.8	10
1000 ppm	5.9	6.9	6.4	10
1500 ppm	6.7	4.4	5.6	10

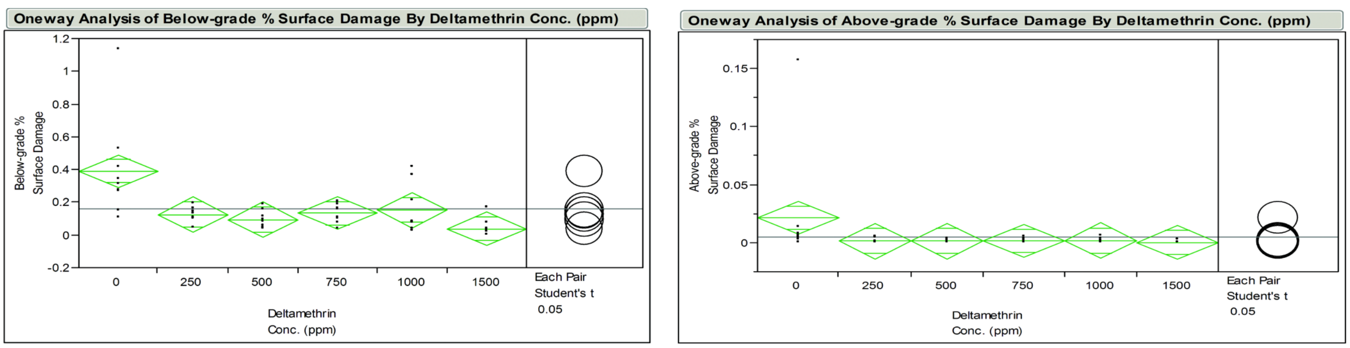

Figure 5 *Molino, FL statistical analysis below grade (left) and above grade (right).*

Table 7. Average ASTM Ratings to Stakes and Bait Wood Gulfport, MS—2005

Deltamethrin Conc. (Treatment)	ASTM Rating for Monitor Stakes
0 ppm	3.5 ± 4.7
250 ppm	2.3 ± 3.8
500 ppm	5.9 ± 3.5
750 ppm	5.5 ± 4.9
1000 ppm	3.2 ± 4.0
1500 ppm	6.7 ± 4.0

any visible signs of termite damage. The specific amount of termite surface damage to each specimen affected was not reported. The data still clearly show that the addition of deltamethrin can reduce or eliminate termite damage.

Data from all three test sites clearly shows a statistical response that adding deltamethrin to polystyrene foam is effective in reducing or eliminating termite damage in area of ‘moderate’ or ‘high’ termite activity (moderate to very heavy termite infestation probability regions). The data did not show a statistically significant difference in the deltamethrin concentration response at 250 ppm deltamethrin and above.

At the Clayton, NC site, although the termite activity was ‘moderate’, the average number of termite holes in the control foam insulation samples was over 190. Foam samples containing deltamethrin all showed a statistically significant lower amount of surface area damage caused by termites. Foam samples with 250 ppm deltamethrin and higher showed less than 0.2% surface area damage in below-grade samples and much less in above-grade samples.

At the Molino, FL test site with ‘high’ termite activity, foam samples with a deltamethrin concentration greater than 250 ppm also showed less than 0.2% surface area damage on the worst case below-grade samples and no termite tunnels were observed extending into the foam on these samples. Again, all samples containing deltamethrin show a statistically significant lower amount of surface area damage as compared to the control.

The termite activity at the Gulfport, MS test site was highest among the three test sites with 74% of all monitoring stakes being attacked by termites. Termites tunneled through 6 of 10

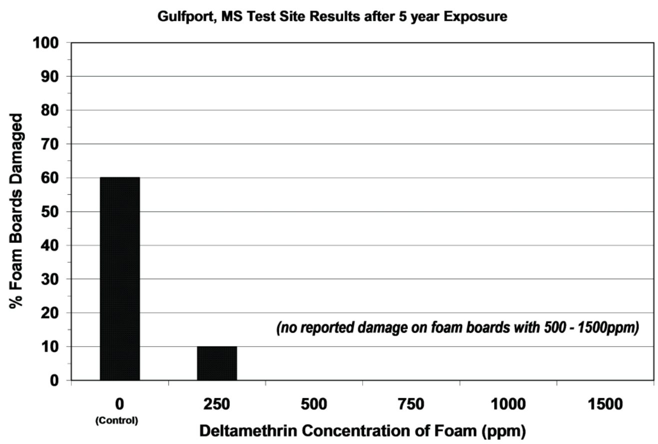

Figure 6 *Termite-resistance data from Gulfport, MS.*

control foam samples up to the bait wood on top of the foam specimens. Only 1 foam specimen containing 250 ppm deltamethrin showed visible signs of termite damage and no foam specimens with 500 ppm or greater deltamethrin showed any signs of termite attack.

Based on the data, researchers from each test site concluded that incorporating deltamethrin into the formulation for extruded polystyrene insulation will significantly reduce termite attack and damage. These results confirm that foam insulation containing deltamethrin meet the requirements for termite-resistant foam plastics as established in the ICC-ES EG239 guideline.

Foam insulation samples were collected from each test site annually and analyzed for deltamethrin content by a Bayer Environmental Science laboratory in Kansas City, MO. The amount of deltamethrin in the foam samples was determined using solvent extraction follow by liquid chromatography with detection. Concentration levels were determined using relationships established by calibration standards. The results of deltamethrin content measurements of the extruded polystyrene insulation sample over time are shown in Table 8. The deltamethrin concentration for both the 250 ppm and 1500 ppm samples remained essentially constant over the five-year test period, confirming the presence and stability of the deltamethrin content level in the insulation over time.

The U.S. EPA has reviewed this long-term field efficacy study data along with environmental, health and safety data and approved the use of deltamethrin to protect polystyrene insulation from termites. The U.S. EPA issued the following statement which is required to appear on the deltamethrin product label:

For use in the manufacture of polystyrene foam insulation to protect it from termites and other wood destroying insects. For optimum performance, deltamethrin should be incorporated into polystyrene foam insulation at a rate between 750 and 1500 ppm active ingredient. [Trade name for deltamethrin] can be either added directly to the foam extrusion process or separately compounded in a polystyrene resin concentrate which is then added to the foam extrusion process. Alternatively, [Trade name for deltamethrin] can be coated on the polystyrene beads, and incorporated into the foam during the molding process. Finished board will have the following labeling: Polystyrene foam [or Company trade name for foam] insulation contains deltamethrin [or Trade name for deltamethrin] insecticide to which will protect the foam from termites and other wood destroying insects.

SUMMARY/CONCLUSIONS

Extruded polystyrene insulation containing deltamethrin, a very effective termiticide with contact repellency characteristics, provides a robust solution to keeping termites out of the insulation without adversely affecting its physical properties. The effectiveness of this solution has been confirmed both in a short-term extreme field exposure study and a long-term field performance study conducted in accordance with U.S. EPA and ICC-ES industry evaluation protocols.

The short-term study showed that deltamethrin provided significant protection of extruded polystyrene insulation against both *R. flavipes* and *C. formosanus* termites.

Analytical measurements of the deltamethrin content levels in extruded polystyrene insulation samples retrieved from the long-term field performance study confirmed the presence and stability of the deltamethrin level in extruded polystyrene insulation over time.

The results of the long-term field performance study showed that extruded polystyrene insulation containing deltamethrin met the ICC-ES EG239 acceptance criteria for termite-resistant foam plastic.

The U.S. EPA has also reviewed the long-term field performance study data along with environmental, health and safety data and has approved the use of deltamethrin to protect polystyrene foam from termites.

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Table 8. Deltamethrin Concentrations Over Time (Average of Three Test Sites)

	Nominal 250 ppm Sample		Nominal 1500 ppm Sample	
Year	**Above-Grade**	**Below-Grade**	**Above-Grade**	**Below-Grade**
0[1]	257.0	257.0	1464.0	1464.0
1	255.0	257.7	1494.0	1503.3
2	267.0	268.0	1466.5	1474.0
3	282.5	275.7	1649.5	1583.3
4	264.0	270.0	1506.3	1488.3
5	250.5	249.0	1555.5	1468.5

[1] Average of three samples submitted to test sites.

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