IRG/WP 01-30274

THE INTERNATIONAL RESEARCH GROUP ON WOOD PRESERVATION

Section 3 Wood Protecting Chemicals

NEW APPLICATIONS OF SILAFLUOFEN TO TERMITE CONTROL

Koji Nakayama, Yoshihiro Minamite, Shinobu Koike and Yoshio Katsuda

Dainihon Jochugiku Co., Ltd., 1-11, 1-Chome Daikoku-cho,

Toyonaka, Osaka 561-0827, Japan

Koichi Nishimoto, Professor em., Kyoto University

Japan Wood Preserving Association, 2-5, 4-Chome Toranomon,

Minato-ku, Tokyo 105-0001, Japan

Paper prepared for the 32nd Annual Meeting

Nara, Japan

May 20-25th, 2001

IRG Secretariat

c/o KTH

SE-100 44 Stockholm

Sweden

NEW APPLICATIONS OF SILAFLUOFEN TO TERMITE CONTROL

Koji Nakayama, Yoshihiro Minamite, Shinobu Koike, Yoshio Katsuda, K Nishimoto

ABSTRACT

Silafluofen-based termiticides are widely used for soil and timber treatments in Japan, as silafluofen possesses advantageous properties of low fish toxicity and high chemical stability (to light, in soil, in alkaline environments, etc) in addition to high termiticidal activity and low mammalian toxicity.

As new applications of silafluofen to termite control, we have developed another type of products in the forms of practical anti-termitic plastic sheets and anti-termitic plastic heat insulators which are free from the exposure risk of termite control operators and inhabitants to the sprayed chemical.

Anti-termitic plastic sheets containing silafluofen in ethylene vinylacetate copolymer film have already been put into practical use, showing a high anti-termitic effect. Plastic heat insulators made of such materials as polystylene and polyurethane have the problem of the decrease in their insulating effect due to termite damage, although they have been widely used as building materials. To solve this problem, we prepared anti-termitic plastic heat insulators by impregnating silafluofen at concentrations of 0.1 ～0.3 % into plastic foam. As a result of anti-termitic efficacy tests against Coptotermes formosanus Shiraki, these plastic heat insulators were found to be effective in suppressing the termite damage.

Key words : Silafluofen, Termite control, Anti-termitic plastic sheet, Anti-termitic plastic heat insulator.

1. INTRODUCTION

Silafluofen (1), an insecticide containing silicon, was invented by Katsuda et al in 1984. This compound has been under practical uses in various pest control areas including termite control (2,3) and agricultural purposes, as it is characterized by low fish toxicity and high chemical stability in addition to excellent properties of conventional pyrethroids such as rapid knock-down effect and low mammalian toxicity.

We have been engaged in development works on silafluofen-based termiticides (Table 1), and two types of products have been on the market with good reputations: E.C. for soil treatment from 1991 and oil formulations for timber treatment from 1992, respectively.

Table 1 Silafluofen-based termiticides

Items		E.C. for soil treatment	Oil formulation for timber treatment		
Active ingredient	Termiticidal	Silafluofen 3.0 %(W/W)	Silafluofen 0.15 %(W/W)		
	Fungicidal	———	Samplas * 1.2 %	Cyproconazole 0.1 %	IPBC ** 1.0 %
Usage		30 part dilution (A.I.: 0.1 %)	Without diluting		
Application rate		3 L /m^2 to soil	0.3 L /m^2 to timber		

* Samplas: 3-bromo-2,3-diiodo-2-propenylethyl carbonate
** IPBC : 3-iodo-2-propynyl N-butyl-carbamate

Authorized by Japan Wood Preserving Association and Japan Termite Control Association, these silafluofen-based termiticides hold the following remarkable advantages over pyrethroids and organophosphorus compounds.

Table 2 Characteristics of silafluofen-based termiticides

Termiticidal ingredient	Efficacy	Safety to users	Stability			Fish toxicity
			Sunlight	Soil	Alkaline environ.	
Silafluofen	○	○	○	○	○	○
Permethrin	○	○	△	△	×	×
Chlorpyrifos	○	×	○	△	×	×

○ : Excellent, △ : Moderate, × : Not good.

In treating established houses for termite control, E.C. and oil formulations are usually sprayed under the floor. However this termite control operations are toilsome and carry the exposure risk of operators and inhabitants to the sprayed chemical, making the development of new control methods a pressing need. As another matter, plastic heat insulators made of such raw materials as polystylene and polyurethane have the problem of the decrease in their insulating effect due to termite damage, although they have been widely used as building materials.

As new applications of silafluofen to termite control, we have developed anti-termitic plastic sheets (4) and anti-termitic plastic heat insulators (5) by impregnating silafluofen into plastic film and plastic foam.

This paper deals with these practical anti-termitic products utilizing silafluofen's characteristics.

2. MATERIALS AND METHODS

2.1. Test materials

2.1.1. Anti-termitic plastic sheet

Test sheets were prepared by impregnating silafluofen into plastic materials including ethylene vinylacetate copolymer film (thickness: 0.18 mm).

2.1.2. Anti-termitic polystylene heat insulator

After adding a determined amount of silafluofen to polystylene granules at the primary foaming process, test heat insulators were prepared by impregnating silafluofen at concentrations of 0.1～0.3 % (A.I.) at the secondary foaming process.

2.1.3. Anti-termitic polyurethane heat insulator

Poly-ol containing a determined amount of silafluofen, polyisocyanate and foaming agent were mixed into the foaming process to prepare test heat insulators containing silafluofen at a concentration of 0.3 % (A.I.). Two kinds of heat insulators were prepared using two types of poly-ol as raw material.

2.2. Test methods

2.2.1. Anti-termitic plastic sheet

A 15 cm-square frame (height; 10 cm) not having a bottom was formed using a plastic plate (width; 10 cm, thickness; 5 mm), and a test sheet was put to cover the hollow bottom and fixed on the outer side of the frame with a tape. As shown in Fig. 1, a bait block (base; 5 x 5 cm, height; about 8 cm) was placed inside on the sheet having each 2 holes of ϕ 3 mm and ϕ 5 mm at positions 5 mm apart from the bait block to make a test sample. As an control sample, a ethylene vinylacetate copolymer film sheet untreated with a termiticide was used instead of the above-mentioned test sheet. Two test samples and two control samples were placed on the soil surface of a termite-rearing container of <u>C. formosanus</u> at Wood Research Institute of Kyoto University and observations were made for termite damage to the samples after determined test durations.

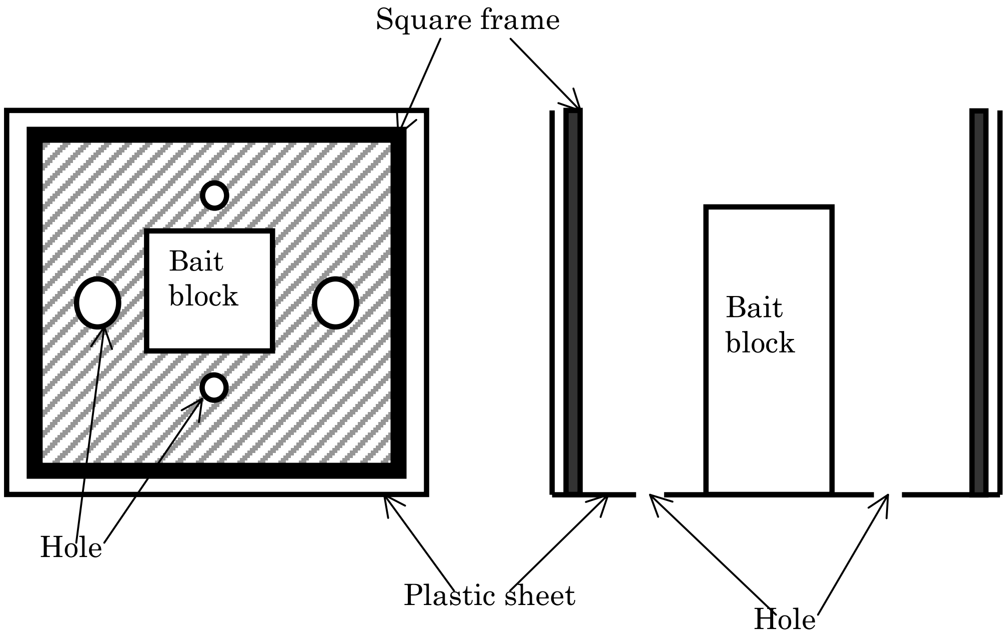

Fig. 1 Test method of anti-termitic plastic sheet.

2.2.2. Anti-termitic polystylene heat insulator

Method A. On a test heat insulator (base; 7.5 x 14.5 cm, height; 2.5 cm), a plastic box not having a bottom (base; 6 x 12 cm, height; 4 cm) was set up, and jointed. One hundred workers and 10 soldiers of C. formosanus reared at Central Research Laboratory of Dainihon Jochugiku were released into the plastic box, in which 3 bait blocks (1 x 1 x 2 cm) and absorbent cotton for termite's access to water were placed. Thereafter this plastic box was put in a plastic container with moist absorbent cotton sheet on the bottom (base; 16.5 x 22.5 cm, height; 8 cm) and the container was kept in a dark room (temp.; 28±2 ℃). After determined test durations, the termite activities on the heat insulator were observed, and evaluations were conducted for mortality of termites on the heat insulator and that of escaped termites from the heat insulator. For a control, a heat insulator untreated with a termiticide was used (Fig. 2).

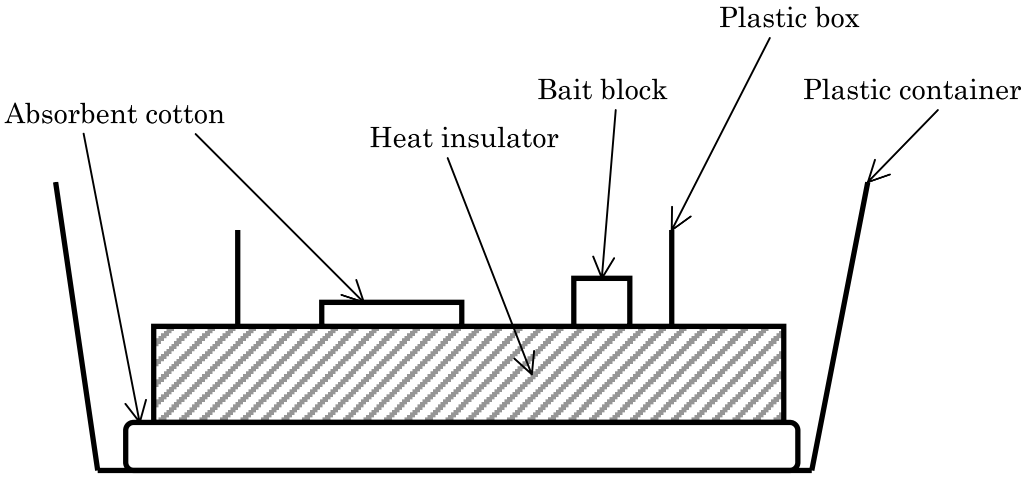

Fig. 2　Test method of anti-termitic polystylene heat insulator(A).

Method B. Two test heat insulators and two other heat insulators untreated with a termiticide (base; 7.5 x 7.5 cm, height; 2.5 cm) were placed alternatively on the soil surface of a termite-rearing container which was connected with a main container having a termite nest of C. formosanus at Central Research Laboratory of Dainihon Jochugiku.), These heat insulators on which 7 or 8 bait blocks (5 x 5 x 20 cm) were placed tightly side by side were kept in a dark room (temp.; 28±2 ℃). Observations were made for termite damage to the heat insulators after determined test durations (Fig. 3).

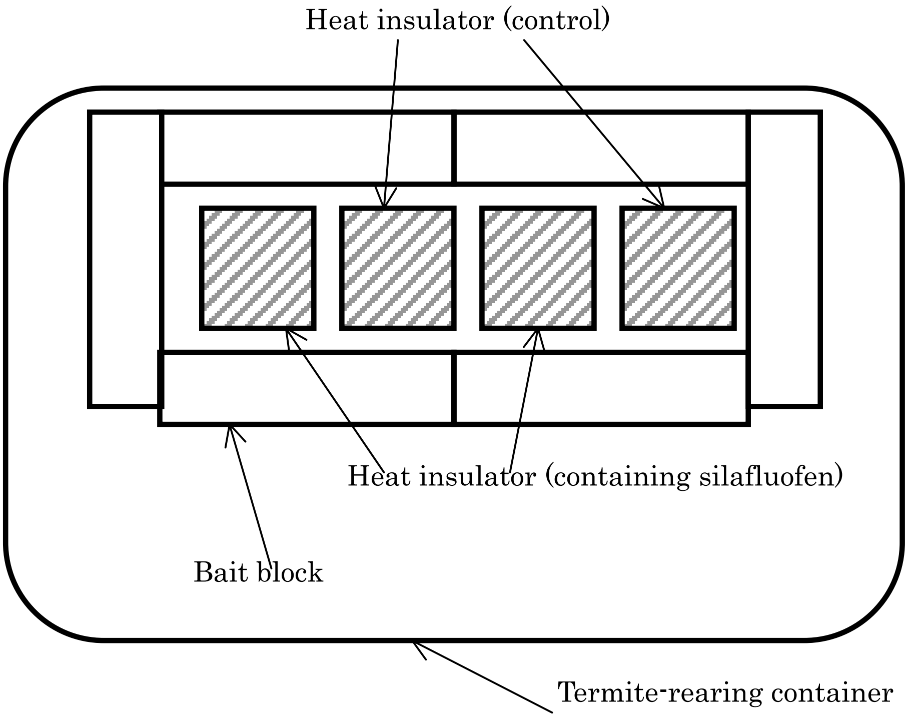

Fig. 3　Test method of anti-termitic polystylene heat insulator(B).

Method C. Two test heat insulators (base; 5 x 7.5 cm, height; 2.5 cm) and 3 bait blocks (5 x 5 x 20 cm) were placed alternatively on the soil surface of another termite-rearing container of C. formosanus at Central Research Laboratory of Dainihon Jochugiku. Those were kept in a dark room (temp.; 28±2 ℃). Observations were made for termite damage to the heat insulators after determined test durations. As a control, a heat insulator untreated with a termiticide was used (Fig. 4).

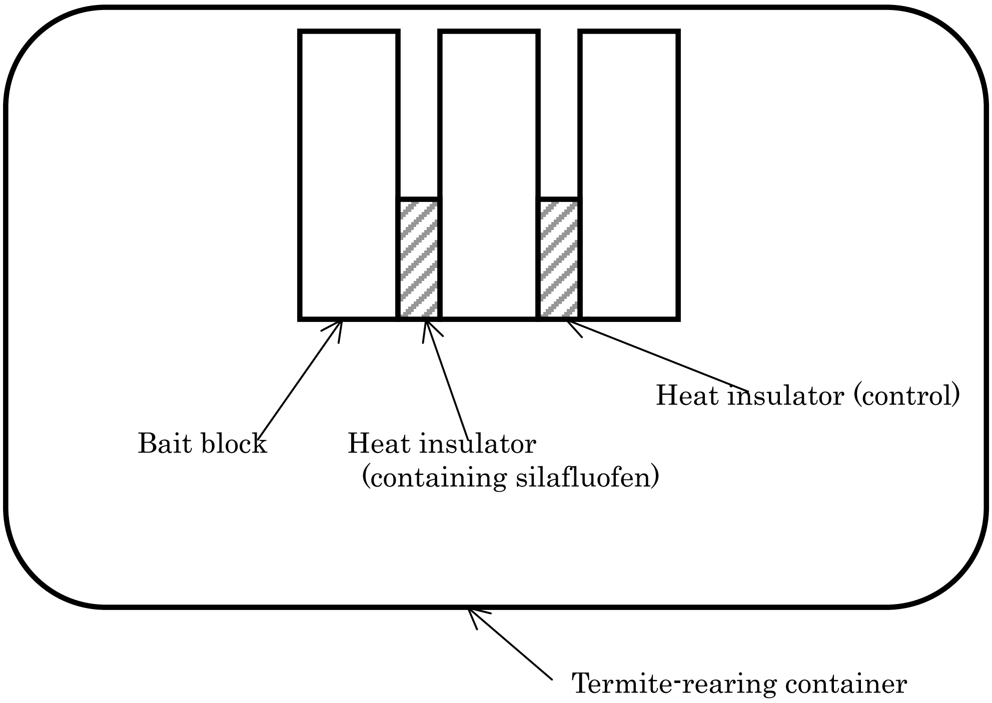

Fig. 4 Test method of anti-termitic polystylene heat insulator(C).

2.2.3. Anti-termitic polyurethane heat insulator

In accordance with Japan Wood Preserving Association Standard No. 11(1), anti-termitic efficacy tests were conducted at Wood Research Institute of Kyoto University. Test heat insulator blocks (1 x 1 x 2 cm) were oven-dried at 60℃ for 48 hours to determine the pre-test weights. In an acrylic cylinder (φ 8 cm, height; 6 cm) having one end sealed with hard plaster of Paris to form a 5 mm thick bottom, a test block was placed, and then 150 workers and 15 soldiers of C. formosanus reared at Wood Research Institute of Kyoto University were introduced. A large covered case including several cylinders and moist absorbent cotton on the bottom was kept in a dark room (temp.; 28±2 ℃). After 21 day test duration, the test block was taken out, and then debris and adherent matters were removed away from the surfaces of the test block. Weight of the test block was measured in the same way to determine the rate of weight loss. The average mortality was recorded at the termination of the test. Tests were conducted in 5 replicate.

3. RESULTS AND DISCUSSIN

3.1. Anti-termitic plastic sheet

Table 3 shows observatory results of bait blocks after installation.

Table 3 Test results of anti-termitic plastic sheets

Test sample	Months after installation			
	1 ～ 6	8	10	12
Test sheet (1)	No damage	No damage	No damage	No damage
Test sheet (2)	No damage	No damage	No damage	Minor damage on the bottom of the block and the sheet under the block.
untreated sheet	Termite damage advanced rapidly after the formation of mud tubes on the block.			

Test anti-termitic plastic sheets showed a high anti-termitic effect even under the severe conditions that the sheets were made holes beforehand and were placed in a rearing container of C. formosanus , and were found to be practically effective.

3.2. Anti-termitic polystylene heat insulator

Method A. Observatory results after 7 day test duration are shown in Fig. 5.

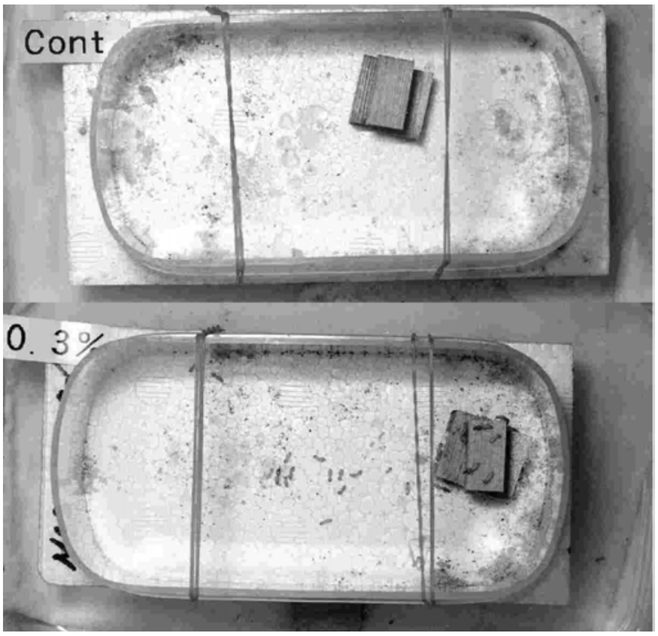

Fig. 5 Test result of heat insulator (silafluofen 0.3%) and heat insulator (control).

As for heat insulators untreated or treated with silafluofen at a concentration of 0.1 %, almost all termites crept into the heat insulators and no termite was observed on the surface of the insulators. In contrast, heat insulators containing silafluofen at concentrations of 0.2 and 0.3 % kept a large number of termites on the surface of the heat insulators, indicating a high anti-termitic effect. None of them were found to have crept into the insulators. In case of the latter insulators, the rates of dead termites on and outside the heat insulator against the total released termites were both about 10 % after 7 days.

Method B. Observatory results one day after installation are shown in Fig. 6.

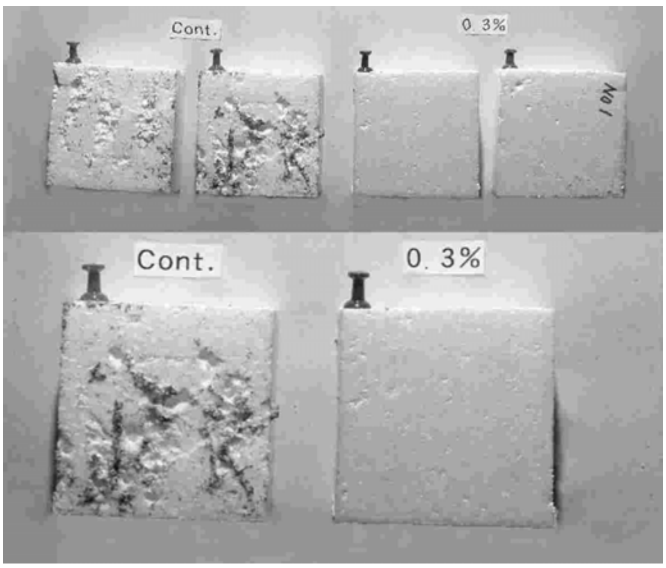

Fig. 6 Test result of heat insulator (silafluofen 0.3%) and heat insulator (control).

Test heat insulators containing silafluofen at concentrations of 0.2 and 0.3 % revealed effectiveness in suppressing the termite damage, with much smaller damage on them than that on the heat insulator untreated with a termiticide.

Method C. Observatory results one day after installation are shown in Fig. 7.

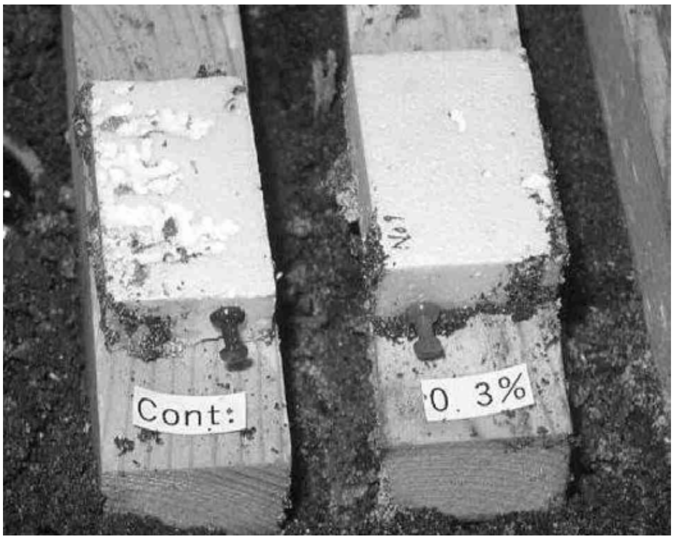

Fig. 7 Test result of heat insulator (silafluofen 0.3%) and heat insulator (control).

In the similar way as the above B), test heat insulators containing silafluofen at a concentration of 0.3 % revealed effectiveness in suppressing the termite damage, with much smaller damage on them than that on the heat insulator untreated with a termiticide.

3.3. Anti-termitic polyurethane heat insulator

Test results are shown in Table 4.

Table 4 Test results of anti-termitic polyurethane heat insulator

Test sample	Average weight loss (%)	Average mortality (%)
Test heat insulator (1) [Poly-ol A]	2.3	18
Test heat insulator (2) [Poly-ol B]	2.8	9
Untreated heat insulator	15.6	7

As a result of tests in accordance with Japan Wood Preserving Association Standard No.

11(1) applied to oil formulations for timber treatment, test heat insulators using poly-ol A and B gave average weight loss of 2.3 and 2.8 % respectively, satisfying the performance requirement of less than 3.0 %. Accordingly, polyurethane heat insulators containing silafluofen at a concentration of 0.3 % were found to show an anti-termitic effect comparable to that of oil formulations.

4. CONCLUSION

Silafluofen-based anti-termitic products were found to be useful in areas of anti-termitic plastic sheets and anti-termitic plastic heat insulators in addition to conventional E.C. for soil treatment and oil formulations for timber treatment. The demand for anti-termitic plastic sheets and anti-termitic plastic heat insulators will increase rapidly in the future, as this system is free from the exposure risk of termite control operators and inhabitants to the sprayed chemical, meeting the social needs. On the ground that these products often make contact with alkaline building materials such as mortar and concrete, silafluofen which is chemically stable in alkaline environments, is considered to be the most promising as an active ingredient for these products.
Further tests are in progress.

5. REFERENCES

1. Katsuda, Y., H. Hirobe & Y. Minamite (Assignee: Dainihon Jochugiku)(1986). Insecticide and miticide containing arylalkylsilicon compounds, and process for producing thereof. JP 61-87687.
2. Minamite, Y., T. Kanzaki, Y. Katsuda & K. Nishimoto (1990). Application of a novel silaneophane (Hoe-498) to termiticides. Jpn. J. Environ. Entomol. Zool. 2: 117-122.
3. Rustenburg, Gb & C. J. Klaver (1991). Silafluofen, a new insecticide against wood-boring insects and termites. International Research Group on Wood Preservation, Doc. No.: IRG/WP/3666.
4. Komai, H., H. Toda & S. Yaga (1996). Efficacy tests of anti-termite system. J. Environ. Control Technique. Vol. 14: 315-319.
5. Hagino, K. (2000). Termite-proofing insulations. Termite. No. 121: 24-36.