EMISSIONS CHARACTERISTICS OF HEAT TRANSPIRED PYRETHROID INSECTICIDE BY A SEMICONDUCTOR HEATER

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ABSTRACT
Pyrethroids have been widely used as insecticide because of its stability; knock down effect to insects or its high fatality rate by the synergists. On the other hand, pyrethroids are generally said that they are hazardless to warm-blooded animal including human beings because it will be metabolized and discharged by the effect of metabolic enzyme. Recently, there are reports of the health effect caused by pyrethroids such as brain damage, decrease of cholinoreceptor, the increase of acetylcholinesterase activity. However there are hardly any reports on pyrethroid insecticide used in indoors. There is a Japanese market specific heat transpired pyrethroid insecticide emitted by a semiconductor heater that is used continuously during the season when there are mosquitoes. However, the characteristic of pyrethroid emission is not well known. The emission characteristics of the pyrethroid emitted by a semiconductor heater measured in a quiescent condition will be reported.

INDEX TERMS
Pyrethroid insecticide, Semiconductor heater, emission characteristics

INTRODUCTION
It is said that one third of the insecticide used in Japan are pyrethroid insecticide. Pyrethroid pesticides well known that it is highly effective to killing insects, but harmless to warm-blooded animals because it will be metabolized or discharged by the metabolic enzyme system by maker's information. However it was been reported that exposure to pyrethroid during the developmental stage will leave irreversible damage such as decrease of cholinoreceptor or the increase of activated acetylcholine esterase, so exposure to pyrethroid should be as less as possible. In Japan, there is a heat transpired pyrethroid insecticide emitted by a semiconductor heater that is used continuously during the season when there are mosquitoes. However, the characteristic of pyrethroid emission is not well known. The emission characteristics of the pyrethroid emitted by a semiconductor heater measured in a quiescent condition will be reported to propose an optimum way of using pyrethroid insecticide.

CHARACTERISTICS OF THE INSECTICIDE
The insecticide consists of alkenes solvents, detergents, antioxidants and from 0.66% to 2.8% of pyrethroid. The solution is including pyrethroid is impregnated in the center core which is

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surrounded by a semiconductor ceramic heater. The insecticide in the center core is heated by the non-contact semiconductor ceramic heater and emitted.

RESEARCH METHODS

The experiment was taken place in a quiescent thermal condition which was controlled to be 25^{O}C. The size of the chamber is 3.4m (x) ×3.4m (y) × 2.5m (z) = 32.4m^3 and the ventilation rate were set at 0.5 (1/h), as shown in Fig.1. The semiconductor ceramic heater was placed on the floor at the center of the room. Then the insecticide was transpired for 24hr. This insecticide transpired about 70mg/hr. Thermal plume from the semiconductor ceramic heater was monitored by a thermo viewer (NEC San-ei Instruments Ltd., Type TH31 02MR). The target compounds were sampled at the sampling points shown in Fig.2. The target compounds were Furamethrin ($C_{18}H_{22}O_3$) 2.7% as pyrethroids, Diehylene-glycol-monobutyl ether(DEGBE) 66.5% as solvents and Butylated-hydroxyl-toluene(BHT) 0.5% as antioxidants. Sample air was collected by the airflow rate at 1 L/min. for 6 hours to a C18 cartridge (Waters Sep-pak C18 cartridge) then extracted by 10 mL of acetone. Gas and particle phase insecticide were also collected to an Empore C18 Disk filter and a glass filter (Whatman GF/A). Settling particles were collected to a glass filter. The extracted solvent was analyzed by gas chromatography mass spectrometry (GC/MS). The analytical conditions will be shown in Table 1.

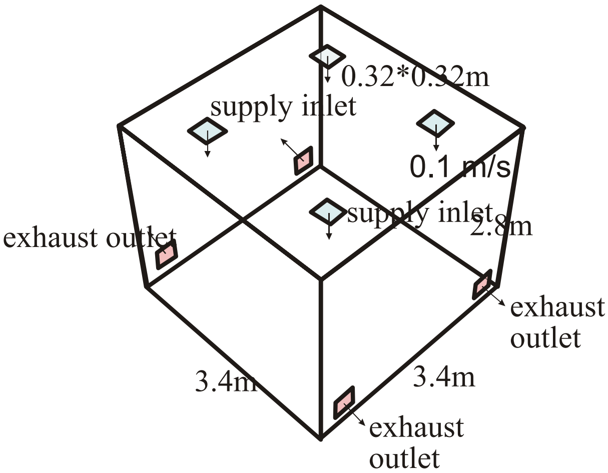

Figure 1. *Diagram of experimental room*

Table 1 *GC/MS conditions*

Instrument	ALS-GC/MS Hewlett Packard 6980, 5973N
Column	HP5 30m x 0.25mm x 0.25um
Carrier Gas	He at 1mL/min.
Oven Temp.	50°C – 10°C/min. – 240°C(1min.) – 5°C/min. – 300°C(5min.)

The emission characteristics of each compounds was determined in a chamber sized 0.5m (x) x 0.5m(y) x 0.25m (z). The insecticide was transpired for 24hr. Transpired insecticide was collected on a glass filters that were set on the floor, wall, and ceiling of small chamber. Sampling positions are shown in Fig. 5. The air inside of the chamber was collected by polyurethane foam sampler (PUF Sampler) after transpired. Glass filters and PUF samplers were extracted by

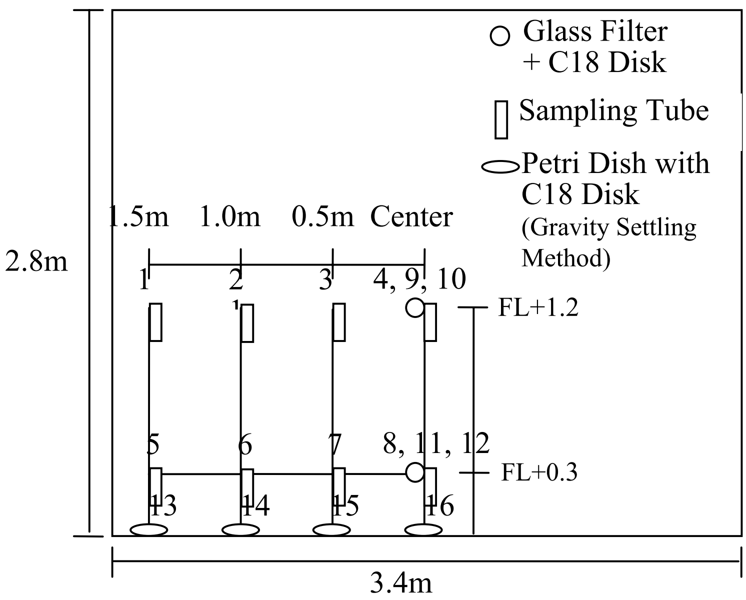

Figure 2. *Sampling positions*
(The numbers represent the sample number)

ultrasonic with 5mL of acetone and sonication was continued for 20min. The extracted solvent was induced to a GC/MS and analyzed qualitatively and quantity.

RESULTS AND DISCUSSION

The thermal plume monitored by the thermal viewer will be shown on Fig. 3. The temperature of the center core was 54.5^{O}C and ceramic heater surrounding the center core was 93.5^{O}C. The thermal plume extended up to 20 cm above the top of the heater that is about 30 cm above the floor. As a result, the diffusion of the pyrethroid insecticide from the semiconductor ceramic heater is effected by the air flow around the heater.

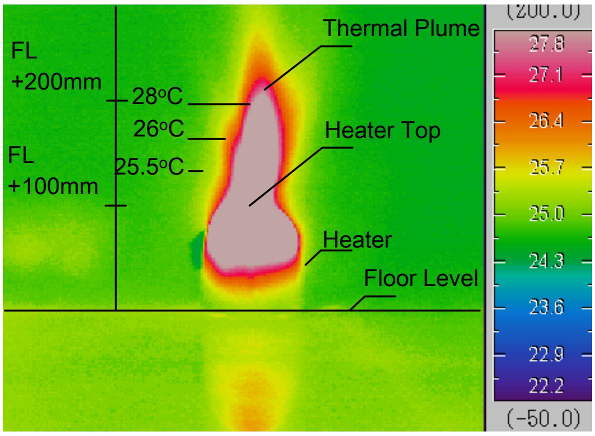

Figure 3. *Thermography of the semiconductor ceramic heater and the thermal plume*

The solvent intensity will be shown in Fig.4. The solvent intensity was largest at the height of 0.2m above the floor at the position of directly above the semiconductor ceramic heater. In other positions, the solvent intensity was largest at 1.0m away from the source at the height of 1.2m the intensity decrease from that position, so from this a tendency of insecticide to diffuse diagonally to 1.0m from the source was observed. There were more gas phase insecticide than the particle phase insecticide at the height of 0.2m above the source; however the ratio became nearly equal at the position 1.2m above the source. From this, the insecticide which emitted as gas phase instantly changed into mist or particle phase by aggregation.

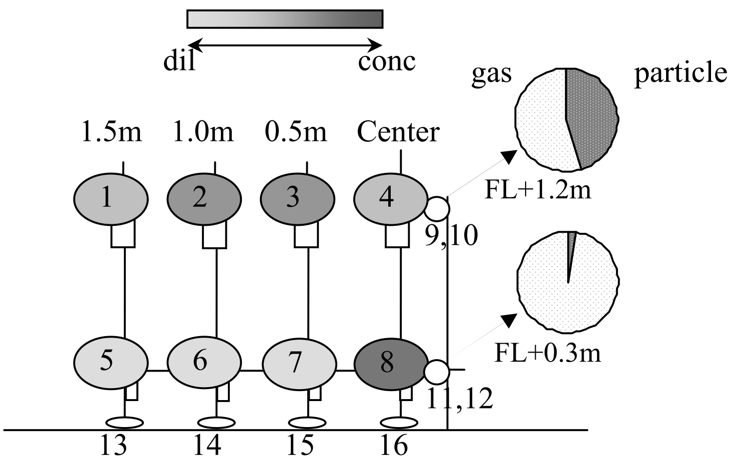

Figure 4. *Sampling positions and solvent distribution*

The weight of the insecticide was measured before and after the experiment and the insecticide transpired was 4,264mg. The solvent intensity will be shown in Fig.5 and amount of each compound on glass filers will be in Table 3. Among all compounds, large amount of compounds were collected directly above the semiconductor ceramic heater. Furamethrin was not detected from the air sampled in the chamber. Therefore, most of the insecticide, especially Furamethrin, agglutinates to the first contacting material.

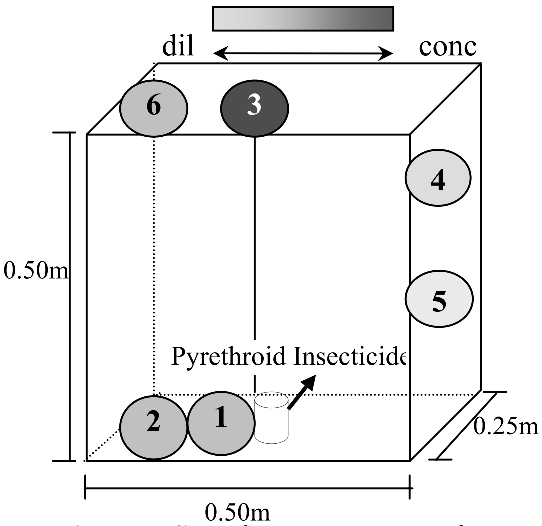

***Figure5.** Sampling positions and solvent deposition*

***Table2.** Amount of transpired compounds*

Compound	DEGBE	BHT	Furamethrin
	2836	21.32	115.13

(mg)

***Table 3.** Amount of collected compounds*

Sample No. (Fig.5)	Amount (mg)		
	DEGBE	BHT	Furamethrin
1	1.42	0.01	0.40
2	1.00	N.D.	0.38
3	86.32	1.07	6.87
4	0.17	N.D.	0.38
5	N.D.	N.D.	N.D.
6	1.97	0.01	0.38
air	10.74	0.03	N.D.

No.1～6 (0.0075 ㎡ glass filter)

CONCLUSION

Emissions characteristic of heat transpired pyrethroid insecticide by a semiconductor heater was observed in a quiescent thermal condition room. The thermal plume extended up to 20 cm above the top of the heater, therefore the diffusion of this insecticide is effected by the air flow.

By the measurement of this insecticide's compounds (DEGBE, BHT, Furamethrin), we can know that the insecticide which emitted as gas phase instantly changed into mist or particle phase by aggregation. Most of this insecticide's compounds agglutinated on first contacting material, and this tendency is pronounced in Furamethrin. By these results, when using the heat transpired pyrethroid insecticide, the setting place of the insecticide should be chosen. So that the insecticide aerosol will not be inhaled and thing which have a possibility to be taken into the mouth, i.e. toys, dishes, and etc., should not be place where the first contact to the pesticide might occur.

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