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Application Characteristics of Sprayer with Twin-fluid Nozzle.

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ABSTRACT

A comparison was made on application characteristics between a sprayer with twin-fluid nozzle and conventional sprayers for PCO's (pest control operators). It was found that the application characteristics of Actisol sprayer were superior to those of such conventional sprayers as a compressed air sprayer and an aerosol sprayer in respect to the penetrating perfomance and the deposition efficiency of spray droplets in structural wall clearances used by cockroaches and other insect pests as their harbourages.

Actisol sprayer is considered to be suitable for the agriculture area (for instance, green houses) because it is small and portable in spite of a compressor in its system, and applies chemicals by dry treatment. It appears, additionaly, that Actisol sprayer may be used as an electrostatic sprayer because its output corresponds to very low volume or ultra low volume application.

Introduction

It is said that the application characteristics of a sprayer with twin-fluid nozzle are to generate fine and uniform spray droplets by using pressurized air and liquid, and to carry the spray droplets over to distant targets with the air stream also generated by itself[2,5]. The spray system using twin-fluid nozzle has been widely used in the paint spraying industry, and this system has commonly a large compressor.

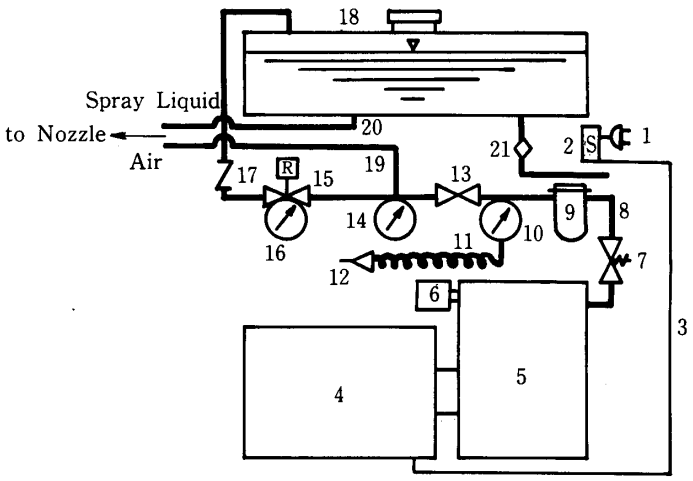
As Actisol sprayer with twin-fluid nozzle has a small compressor, it is easy to carry about, and applies chemicals by dry treatment. This spraying system has been recently imported from U. S. A. and has been used by PCO's to treat offices, storehouses and kitchen in buildings. The purpose of this paper is to make certain of the facts about the penetrating performance and deposition efficiency of spray droplets generated by a sprayer for PCO's with twin-fluid nozzle.

Materials and Methods

In order to compare the application characteristics, an Actisol sprayer with twin-fluid nozzle and conventional sprayers as a compressed air sprayer or an aerosol sprayer were used.

Schematic layout of Actisol sprayer is shown in Fig. 1. The specifications of this sprayer are shown in Tab. 1.

Travel time required by spray cloud of droplets to reach position A from nozzle as shown in Fig. 2 was



1. Electrical Connector (100 V Single Phase)
2. Switch
3. Cord
4. Motor
5. Compressor
6. Air Filter
7. Safty Valve
8. Plastic Tubing
9. Moisture Filter
10. Coiled Tubing
12. Air Chuck
13. ON/OFF Valve
14. Pressure Gauge
15. Regulator
16. Pressure Gauge
17. Check Valve
18. Tank
19. Plastic Tubing
20. 〃 〃
21. Tank Drain

Fig. 1 Schematic layout of tested Actisol sprayer

Tab. 1　Specifications of tested sprayers

	Actisol sprayer	Compressed air sprayer	Aerosol sprayer
Dimensions (mm)	450×522×874H	φ200.5×380H	380m*l*canned
Dry weight(kg)	22	3.5	−
Solution tank capacity(*l*)	3.0	5.0	0.38
Pressure(kPa)	100-130	270-550	430-440
Output(m*l*/*min*)	27-37	280-350	20
Spray angle(°)	17	90	15
Compressing method	Compressor	Hand operate	LPG
Standard spray volume (m*l*/m²)	20	50	20
Spray liquid	Water base	Water base	Oil base

measured with a stop-watch. The penetrating performance of spray droplets was measured by a box as shown in Fig. 2, and was evaluated by the deposition volume on paper target at position A.

The examination of deposition efficiency was carried out using spray liquids of 0.5% red-dye solution, such as direct-scarlet in the water base and oil-red in the oil base spraying.

The deposition was evaluated on the basis of colour darkness on paper targets, and the colour darkness was measured with photo-cell detector of diesel smoke meter[3]. Output current of photo-cell-detector varying with the colour darkness of paper target was changed into the percentage of smoke meter, and that percentage was converted into deposition volume (m*l*/m²).

To check up on the deposition efficiency, the deposition volume was converted into deposition index. Index value 1 equals the deposition volume in agreement with standard spray volume of each sprayer as shown in Tab. 1.

Calibration curves used for evaluating deposition index are shown in Fig. 3. Calibration curve on a compressed air sprayer was omitted in this paper. The placements of the paper targets for evaluating the deposition efficiency are shown in Fig. 4 and Fig. 5.

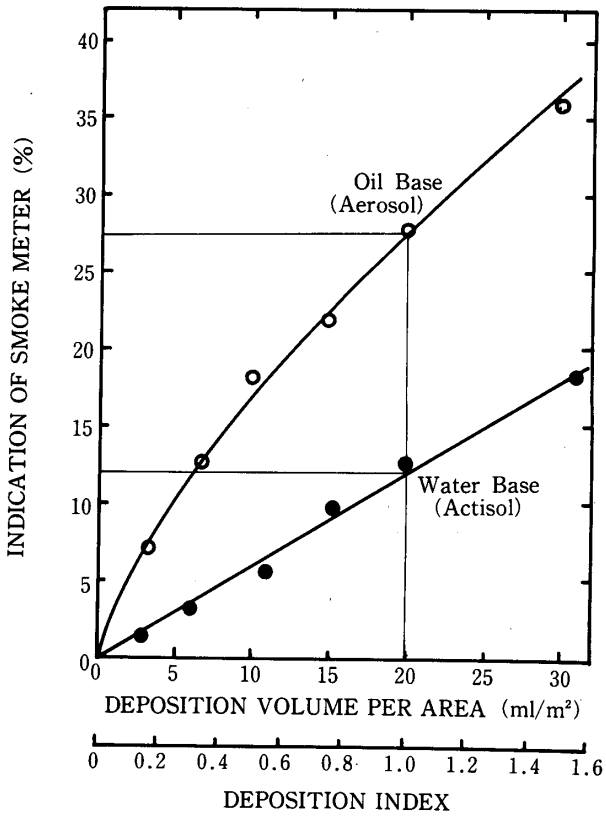


Fig. 3　Relationsphip between indication of smoke meter and deposition volume

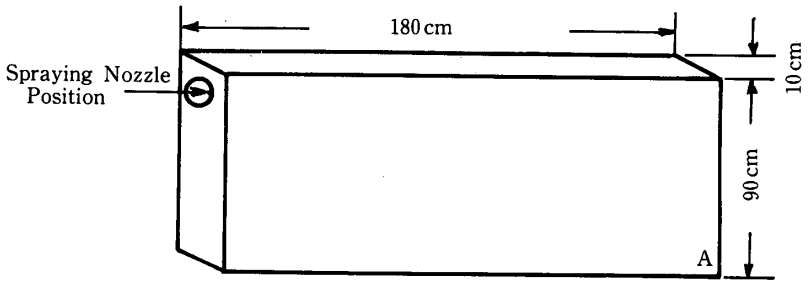
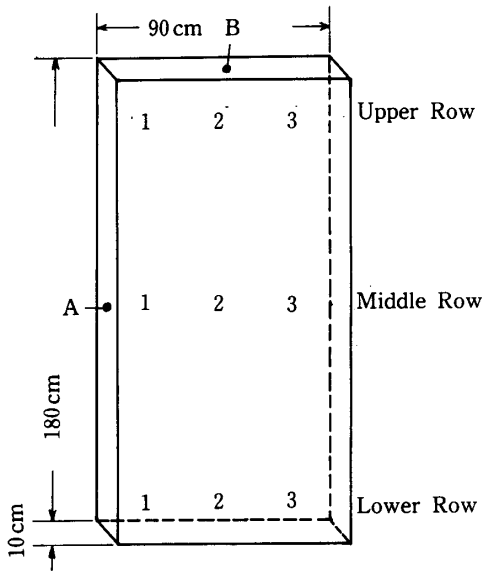
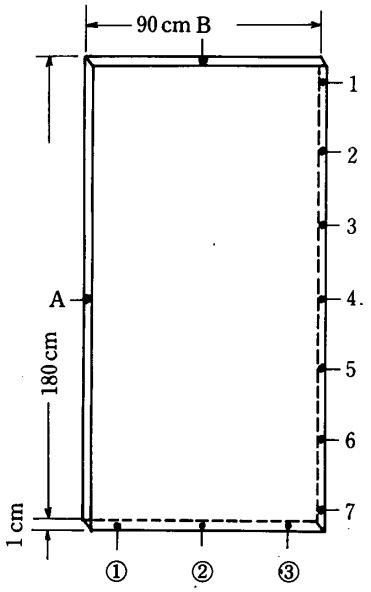


Fig. 2　Dimensions of the box to measure penetrating performance of spray droplets



Spraying Nozzle Position: A or B
Placements of Paper Targets: 1, 2 and 3 of Upper, Middle and Lower Row each.

Fig. 4 Spraying nozzle positions and placements of paper targets inside the box with 10 cm clearance



Spraying Nozzle Position: A or B
Placements of Paper Targets: 1～7 and ①～③

Fig. 5 Spraying nozzle positions and placements of paper targets inside the box with 1 cm clearance

In the case of the placements of paper targets as shown in Fig. 4, the surfaces of paper targets were aligned perpendicular and paralleled to the droplets stream. Each test of deposition efficiency was repeated three times and the deposition indexes were averaged at every placement of paper target.

Results and Discussion

1) Penetrating performance of spray droplets.

The results of measurement on the travel time of spray droplets from nozzle tip to position A as shown in Fig. 2 are shown in Tab. 2. The deposition volume on the paper target at position A after spraying the red-dye for a spray time is shown in Tab. 3. Judging from Tab. 2 and Tab. 3, it appears that spray droplets did not reach the depth of a narrow clearance where insect pests are hiding in the case of application with conventional sprayers.

The Actisol sprayer with its air stream from the spray nozzle as fast as shown in Fig. 6 is able to shorten the travel time of spray droplets to the target, and to improve the penetrating performance of spray droplets.

Tab. 2 Travel time of spray droplets from nozzle to position A in Fig. 2

Sprayers	Travel time(sec)
Actisol sprayer	2.0
Compressed air sprayer	20.0
Aerosol sprayer	5.0

Tab. 3 Spray time and deposition volume at position A in Fig. 2

Deposition volume : ml/m^2

Spray time (sec)	Sprayers		
	Actisol sprayer	Compressed air sprayer	Aerosol sprayer
3	1.92	0	0
5	2.64	0	0
10	5.04	0	0
20	9.00	0	0
40	−	0	0.56

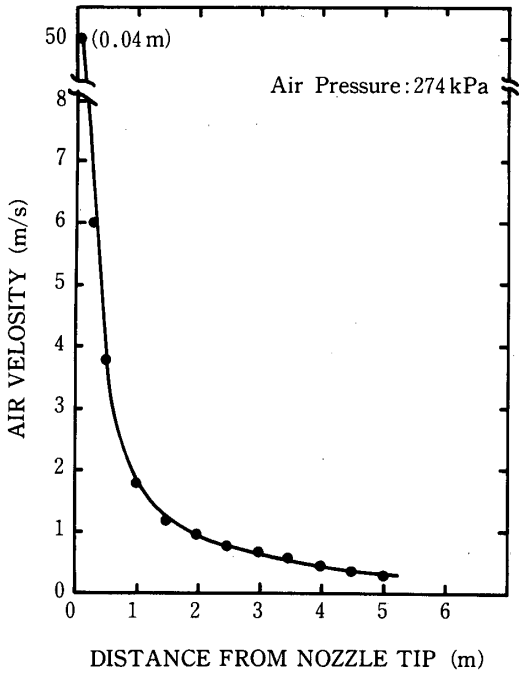


Fig. 6 Distance from nozzle tip and air velosity

2) Deposition efficiency in the case of double wall with 10 cm clearance.

When the surfaces of paper targets were aligned perpendicular to droplets stream, the deposition of red-dye is as shown in Tab. 4 and Tab. 5. At the positions of the targets 1,2,3, both middle and lower row, the deposition index with each sprayer showed more than value 1 except for one position with compressed air sprayer.

At upper row, there was one position of value 0 by spraying with Actisol sprayer, and there were four and five positions of value 0 by spraying with aerosol sprayer and with compressed air sprayer, respectively.

A significant difference between Actisol sprayer and conventional sprayers, thus, was found in the number of value 0 of deposition index in upper row. When the surfaces of paper targets were paralleled to the droplets stream, the deposition indexes of the most part of target were almost value 0 or less than 0.5 excluding the near target of spray nozzle.

Tab. 4 Deposition index (In the case of double wall with 10cm clearance)
(Spraying nozzle position : A)

Sprayers		Positions of paper targets 1	2	3
Actisol sprayer	upper	0	0.3	0.7
Compressed air sprayer	row	0	0	0
Aerosol sprayer		0	0	1.0
Actisol sprayer	middle	1.4	2.3	2.6
Compressed air sprayer	row	0.8	1.0	1.0
Aerosol sprayer		1.6	1.6	1.6
Actisol sprayer	lower	1.4	1.3	1.6
Compressed air sprayer	row	1.1	1.2	1.3
Aerosol sprayer		1.8	1.8	1.8

1) Deposition index: Value 1 equals deposition volume 20ml/m² with Actisol sprayer and aerosol sprayer, 50ml/m² with compressed air sprayer.
2) Sprayed volume: 36ml with Actisol sprayer and areosol sprayer, 80ml with compressed air sprayer.

Tab. 5 Deposition index (In the case of double wall with 10cm clearance)
(Spraying nozzle position : B)

Sprayers		Positions of paper targets 1	2	3
Actisol sprayer	upper	0.4	1.1	0.3
Compressed air sprayer	row	0	0.7	0
Aerosol sprayer		0	1.2	0
Actisol sprayer	middle	2.2	2.1	1.5
Compressed air sprayer	row	1.3	1.1	1.3
Aerosol sprayer		2.4	2.3	2.3
Actisol sprayer	lower	1.6	1.7	1.5
Compressed air sprayer	row	1.2	1.2	1.3
Aerosol sprayer		2.2	2.2	2.2

1) Deposition index: Value 1 equals deposition volume 20ml/m² with Actisol sprayer and aerosol sprayer, 50ml/m² with compressed air sprayer.
2) Sprayed volume: 36ml with Actisol sprayer and areosol sprayer, 80ml with compressed air sprayer.

3) Deposition efficiency in the case of double wall with 1 cm clearance.

To investigate the deposition efficiency of spray droplets in very narrow clearances, a double wall with 1 cm clearance was used. The result is shown in Tab. 6. For the case of spraying from side A (See Fig. 5) with Actisol sprayer, there were no targets of deposition index 0. Both a compressed air sprayer and

Tab. 6 Deposition index (In the case of double wall with 1cm clearance)

Sprayers	Positions of paper targets: Spray nozzle position A 1	2	3	4	5	6	7	position B 1	2	3
Actisol sprayer	0.3	0.6	1.4	2.0	2.0	0.9	0.2	1.3	1.2	1.1
Compressed air sprayer	0	0	0.1	0.2	0.8	0.3	0.2	0.7	1.1	0.7
Aerosol sprayer	0	0	0.1	0.3	0.6	0.1	0.2	1.1	1.2	1.1

1) Deposition index : Value 1 equals deposition volume 20ml/m² with Actisol sprayer and aerosol sprayer, 50ml/m² with compressed air sprayer.
2) Sprayed volume : 36ml with Actisol sprayer and areosol sprayer, 80ml with compressed air sprayer.

aerosol sprayer had two positions of deposition index 0 each.

Although power sprayers and compressed air sprayers have been widely used for the application of chemicals in the PCO area, it seems that effective pest control has not been carried out. That is because it cannot necessarily be said that applied chemicals reach the depth of the clearance of wall in buildings in the case of conventional sprayers.

It is possible for Actizol sprayer to carry the spray droplets with air stream over to the targets, so that the Actisol sprayer has higher deposition efficiency of spray droplets than conventional sprayers.

It was cleared by Dr. K. Tsuga of Reserch Institute for Agricultural Mechanization that Sauter's mean diameter of spray droplets with Actisol sprayer is 10.9 μm at 150 kPa of spray liquid pressure and that the diameter distribution of its spray droplets are concentrated on about 10.9μm of Sauter's mean diameter. This means that the spray method with Actisol sprayer is a low volume or an ultra low volume spray for dry treatment[2,3,4].

With increasing concern about environmental pollution and safety of operator while applying chemicals, it is necessary that the operator appiles as little chemicals as possible, and it is desired that the sprayer system will use dry treatment for the application of chemicals in future.

From the facts described above, the Actisol sprayer is not only a useful system as a pest control sprayer, but as an agricultural sprayer as well. Actisol sprayer is capable of providing better penetration through dense foliage, and can be used a dry treatment for the application of chemicals.

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2流体ノズルを持つ防除機の散布特性

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PCO用（防除業者用）としての2流体ノズルを備えた防除機（アクチゾル・スプレーヤ）の散布特性が，慣行散布法による防除機（蓄圧式スプレーヤ及びエアロゾルスペレーヤ）の散布特性と比較された．アクチゾルスプレーヤの特性は，ゴキブリやその他の害虫が住む建造物の壁の間隙（奥深い棲息場所）への噴霧液の貫通性（到達性）と付着効率に関して，慣行散布機の特性よりもすぐれていることが確認された．

アクチゾールスプレーヤは，コンプレッサーをシステムに持ちながら，小型で可搬性に富み，噴霧液滴が微細なために農薬散布はドライ処理となるので，農業分野(例えば温室）での適用が可能であると思われる．加えて供試機の吐出量は少量または微量散布に相当するので静電散布のシステムに利用できると思われる．