TEFLON® AS A SURFACE FOR DEPOSITION OF AEROSOL DROPLETS [1]

CHARLES H. ANDERSON [2] AND WIL SCHULTE [3]

INTRODUCTION. Commonly used methods in sampling of aerosol sprays involve the deposition of spray droplets on the surface of glass microscope slides. Rathburn (1970) has reviewed these and other methods of sampling.

When the deposited droplets are to be measured, it is essential to accuracy that they not coalesce on the slide and that they assume a fairly uniform round shape. To achieve this, an oleophobic coating is usually applied to the slide. One widely used coating is General Electric Dri-Film,[4] a silicone compound reported by Yeomans (1949). However, it has been found that malathion droplets smaller than 2μ are faintly visible on this surface under a high-dry objective.

It was reasoned that on a more oleophobic surface the lenses formed by the deposited droplets would be more nearly spherical, therefore, more easily visible. Dupont Teflon® plastic film [5] was found to offer such a surface. It has the added property of being insoluble in common solvents, making it useful for sampling a wide range of materials.

In this study, Teflon FEP film, Type A, of 2 mil thickness was used. It was obtained from a local plastics distributor. Other thicknesses are available, but the thicker grades usually have surface imperfections. For droplet sampling, pieces of the film are lightly polished with lens paper, dipped in acetone, and taped to microscope slides. Further polishing after dipping apparently builds up an uneven static charge on the film surface which causes droplets to congregate in dense zones making it difficult to count them. Treatment with a "Static Master" [6] brush reduces this problem somewhat.

DETERMINATION OF "SPREAD" FACTOR. May (1945) gives a method for correcting the diameter of the plano-convex lens formed by the droplet at rest on the slide to the original diameter of the free floating spherical droplet. In this method, the diameter of the base of the lens and the focal length of the lens are measured. From these two measurements, the angle of contact, θ, thence the thickness of the lens are calculated. It is then a simple matter to find the volume of the lens and solve for the diameter of a sphere of the same volume. From this the correction ("spread") factor is derived. However, when θ is greater than 53° (as in the case of malathion on Teflon) May's equation is ambiguous, yielding two values for θ, either of which is plausible.

Faced with this dilemma, it was deemed desirable to find a different way to measure the diameter and height of the lens which would be precise, regardless of the vaue of θ. The following method was developed:

A device was fabricated which allows rotation of the slide material so that droplets can be viewed from the side (Fig. 1). A narrow strip (1–2 mm) of slide material is mounted on the shaft of the device and droplets are collected on this strip by impingement or settling. With the strip parallel to the microscope stage, a droplet of appropriate size near the edge of the strip is chosen for measurement. Care must be used not to choose droplets which are partly over the edge of the strip. Keep-
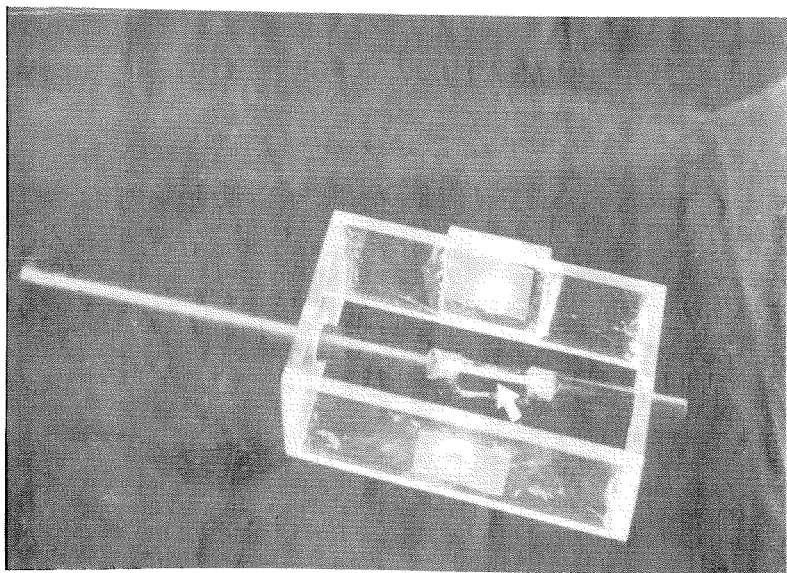
Fig. 1.—Device for viewing droplets from side. Shaft is ¼″ plastic tube. Slide material (arrow) is held in place by soft wax at both ends of opening.

ing the chosen droplet in focus, the strip is rotated 90°. The base diameter and height of the droplet lens are then measured directly.

It is important to measure the droplet precisely first from the top view because, upon rotation, the base of the droplet from side view is indistinct, being somewhat obscured by an "optical horizon" apparently caused by diffraction of light emitted from the edge of the slide material. Knowing the actual diameter of the base, aids in locating the plane of the base so that an accurate height measurement can be made.

To minimize errors of measurement in these tests, the droplet images were projected on a translucent screen and measured with a ruler. Projection was accomplished by employing a compound microscope as a microprojector with a 500-watt slide projector as a light source. The screen was made from a sheet of plastic tracing film taped to a plate of glass.

The projected image of a stage microm-

eter was used to draw a scale upon the screen to aid in estimation of the actual sizes of the droplets being viewed. The microscope was tilted horizontally so that when the droplets were viewed from the side they were resting on a horizontal surface, thus eliminating any distortion of lens shape which might be caused by gravity. The projection setup is shown in Fig. 2. Fig. 3 shows projected images of top and side views of malathion droplets on Teflon and Dri-Film.

After the diameter and height of the droplet lens are measured, calculation of the correction factor is a simple matter of geometry. Since the lens is a segment of a sphere of one base its volume (V_1) is calculated by the formula:

$$V_1 = \frac{1}{6}\pi H (3R^2 + H^2)$$

Where H = height of lens and R = radius of base of lens. The volume of the original spherical droplet (V_2) is given by the formula:
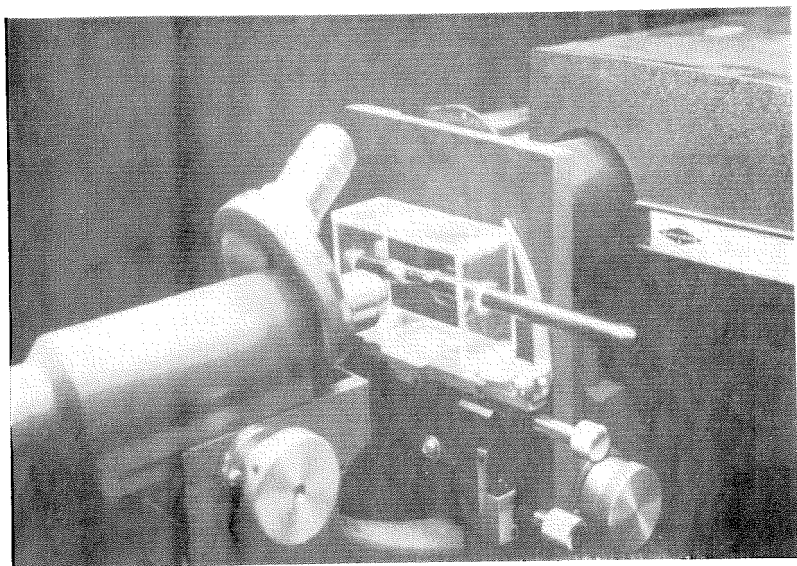
FIG. 2.—Setup for projecting droplet images for measurement.

$$V_2 = \frac{4}{3}\pi \tau^3$$

where τ = radius of spherical droplet.
Since $V_1 = V_2$ then

$$\frac{1}{6}\pi H (3R^2 + H^2) = \frac{4}{3}\pi \tau^3$$

or

$$\tau = \sqrt[3]{\frac{3R^2 H + H^3}{2}}$$

Let C equal the correction factor which, when multiplied by R, will give τ. Then $CR = \tau$ and

$$C = \frac{\tau}{R} = \sqrt[3]{\frac{3R^2H + H^3}{2R}}$$

The correction factor, C, for malathion on Teflon over a wide range of sizes was determined by the direct measurement method. These data are presented in Table 1. In the size range most frequently found in ULV aerosols (5–25μ) it would appear that a single correction factor of 0.69 is sufficient for routine tests of operational equipment.

Further direct measurements were made of malathion droplets on Dri-Film and correction factors calculated. These were compared with correction factors obtained by May's method. For precise measurement of focal length by May's method, a dial indicator, Starret [7] Cat. No. 25–261 was mounted on the microscope as shown in Figure 4. The indicator is marked in 2μ divisions and can easily be read to 0.5μ. The data from these tests are summarized in Table 2.

It is noteworthy that while the correction factor in general use for malathion on Dri-Film is 0.40, (Anon., 1970) these

[7] The L.S. Starret Company, Athol, Massachusetts.

TABLE 1.—Correction factor determination by direct measurement for malathion on Teflon® Film.

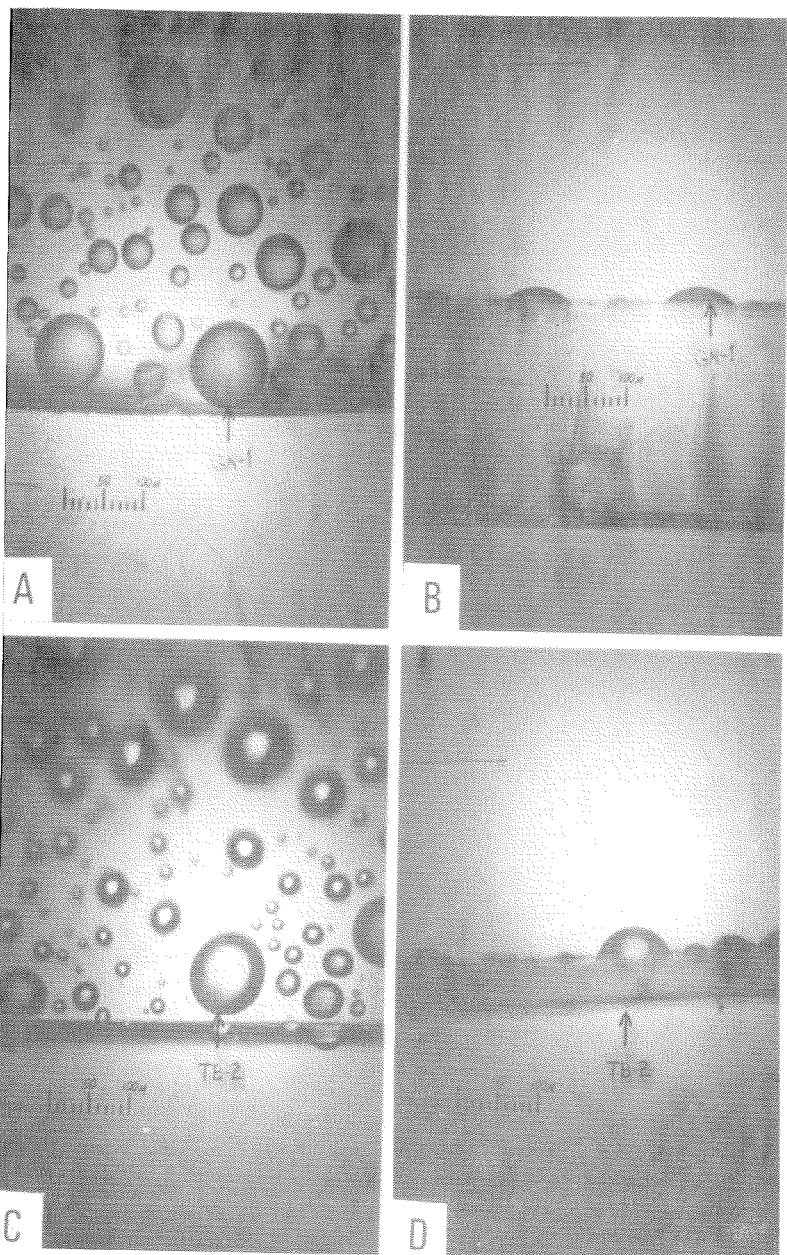| Lens diameter (μ)	Lens height (μ)	Correction factor	Original drop diameter (μ)
96.0	35.4	0.69	66.2
39.5	15.0	0.70	27.7
20.5	7.0	0.67	13.7
11.0	4.3	0.71	7.8
4.0	1.7	0.74	3.0

Fig. 3.—Top and side views of malathion droplets. A and B, droplets on Dri-Film coated glass; C and D, droplets on Teflon Film. Droplet diameters in side view appear smaller because bases are obscured by the "optical horizon" mentioned in the text.
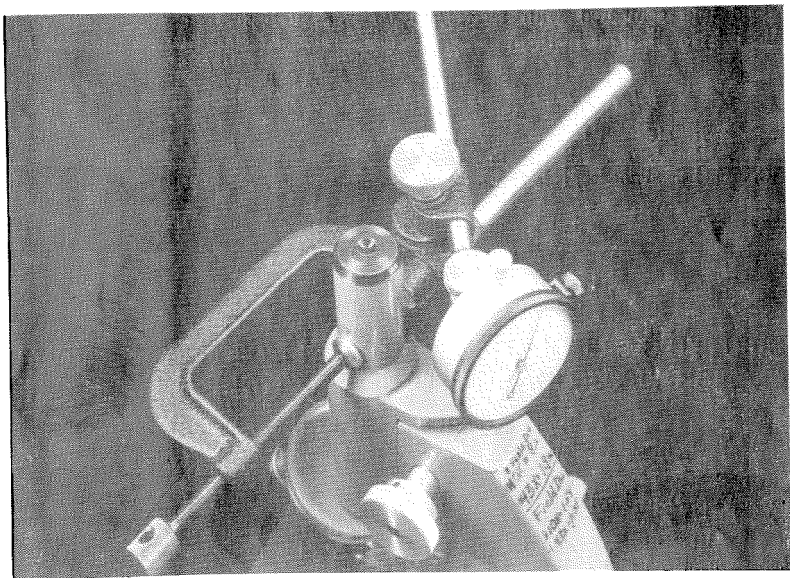
Fig. 4.—Dial indicator mounted on microscope for measurement of focal lengths.

tests show it to be close to 0.52. It may be that the factor may vary with different lots of malathion and/or Dri-Film. It would be wise to determine the correction factor whenever a new batch of either material is introduced into tests.

Effect of Aging. With malathion being relatively non-volatile, and with the small surface/volume ratio of the more spherical droplets on Teflon, the droplet lenses should retain their original diameters for extended periods.

To test this, selected droplets of various diameters were left undisturbed under the microscope for periods up to 4 days in an air-conditioned room. There was no detectable reduction in size of any droplets thus observed.

Summary. Dupont Teflon® film was found to be a suitable material for deposition of aerosol droplets, being more oleophobic than General Electric Dri-Film. A technique was developed for determining correction (spread) factors by direct measurement. Correction factors for malathion on Teflon and Dri-Film were thus deter-

Table 2.—Correction factors for malathion on G. E. Dri-Film coated glass determined by two methods.

"Focal point" method			Direct measurement		
Lens diameter (μ)	Correction factor	Original drop diameter (μ)	Lens diameter	Correction factor	Original drop diameter (μ)
114.0	0.51	58.1	187.0	0.53	99.1
70.3	0.54	38.0	66.0	0.51	33.7
53.2	0.54	28.7	57.0	0.52	29.6
33.25	0.52	17.3	44.0	0.52	22.9
15.7	0.49	7.7	21.5	0.53	11.4
			15.0	0.48	7.2

mined and compared with factors obtained by a different method.

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DIBUTYL O-CRESOL: ITS EFFECTS ON MOSQUITO SURVIVAL AND OVIPOSITION AND ON PLANKTON POPULATIONS

TOSHIAKI IKESHOJI AND STUART H. HURLBERT

Department of Entomology, University of California, Riverside, California 92502

ABSTRACT. Di-tert-butyl o-cresol at 1.8 ppm reduced larval populations of *Culex peus* Speiser in artificial pools by 75 percent for 6–10 days. This chemical also caused the water to become repellent to ovipositing females for a period of 6–10 days. Marked changes in bacterial, algal, ciliate, and rotifer populations occurred following treatment.

From an ecological point of view, development of mosquito larvicides which do not affect non-target organisms is highly desirable. Aquatic predators such as dragonfly nymphs, predaceous beetles, and notonectids frequently exert considerable control over mosquito populations, but are highly susceptible to insecticides now employed in mosquito control programs (Hurlbert *et al.*, 1971). As a result, the long-run effect of insecticide treatment is sometimes to increase mosquito populations (Mulla and Darwazeh, unpublished data).

In the course of our chemical analysis of larval "overcrowding factors" (Ikeshoji and Mulla 1970a, b), substances having much potential as selective insecticides, we found di-tert-butyl p-cresol, an antioxidant added to certain commercial ether preparations, to be highly toxic to mosquito larvae at ecdysis. Subsequently, we tested the toxicities of its three chemical isomers in the laboratory and found the o-derivative to be the most toxic, having an LC_{50} of 0.1 ppm for 1st instar larvae and 1.0 ppm for 4th instar larvae of *Culex pipiens quinquefasciatus* Say. The present paper describes the toxicity of this compound to *Culex peus* under field conditions, its inhibition of *C. peus* oviposition in treated water, and changes in phytoplankton and zooplankton populations resulting from reduction in numbers of mosquito larvae.

The experiments were conducted in six small artificial pools, each 90 cm x 90 cm x 30 cm, and completely lined with a polyethylene sheet that was replaced at the beginning of each experiment. A 2 cm layer of sandy soil was placed on the bottom of each pool. Water from a nearby reservoir was added and maintained at a depth of 20 cm by means of taps equipped with float valves. To attract ovipositing mosquitoes, 300 g of CSMA fly medium were added to each pool at the time of flooding.

Two experiments were performed during July and August, 1970. In each, 300 mg of di-tert-butyl o-cresol dissolved in 3 ml of pure ether were applied with a pipette to the surface of each of three pools. This produced a concentration of 1.8 ppm, equivalent to the LC_{98} for 1st instar larvae and the LC_{75} for the 4th in-