Investigation of droplet-distribution patterns in sprays by means of radioactive tracers
by Robert Itoh

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree
of Master of Science in Engineering Physics
Montana State University
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INVESTIGATION OF DROPLET-DISTRIBUTION PATTERNS IN SPRAYS BY MEANS OF RADIOACTIVE TRACERS

by

ROBERT ITOH

A THESIS
Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Engineering Physics at Montana State College

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Head, Major Department

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Dean, Graduate Division

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July, 1952
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ABSTRACT

A technique using radioactive tracers for determining the total volume of sprayed liquid droplets deposited on glass slides is described. The process used to extract the tracer from RaSO₄ fluorescent disks and dissolve it into water and oil is given. To compare with the volume found by using tracers, a method of finding the total volume by measurements of the droplets, themselves, was used. The measurements by both methods using the oil solution compared well with each other. In general, however, the results for the water droplets as measured by the tracer method were higher than those by the droplet-measurement method. The major source of these differences was apparently due to the non-homogeneous nature of the particles emitted by the tracer.
INTRODUCTION

The effectiveness of the application of insecticides, herbicides, and other liquids by means of spraying depends upon the number and the sizes of the droplets deposited upon a given area. There have been several different methods devised for determining the droplet sizes and the amount of liquid deposited. To determine the size of droplets K. R. May (5) devised a method by considering them as lenses, whereas W. W. Gibbs (2) used their rate of fall. L. D. Goodhue and W. N. Sullivan (3) used a dyed solution and by employing a photoelectric photometer determined the amount of deposit. Other workers determined by chemical analysis the relative deposition on wires of different sizes, but their results did not show clearly the range in sizes of the droplets (6). This investigation proposes to determine the amount of liquid deposited by a method independent of the ones already mentioned. In this method radioactive tracers were used.
PREPARATION OF THE RADIOACTIVE SOLUTION

The radioactive tracer used in this investigation was extracted from flourescent marking disks. These disks were round pieces of cardboard with a hard flourescent salt mixture deposited on one side which was sealed by a transparent organic compound. The salt mixture was composed of ZnS, Phosphor, RaSO₄, and the end products of the radium series which were presumed to be sulphates. The amount of Radium per disk, approximately 20 μg., was determined by comparing one of the disks with RaCl₂ standards.

In order to change the salts into soluble compounds they were first cracked off the cardboard. The salts were then placed in a 150 ml. beaker which was about one-fourth full of concentrated HCl. With the beaker covered the solution was evaporated to dryness, but was not allowed to boil so as to eliminate spattering. This process was used to remove the sulphur from the ZnS. Concentrated HNO₃ was then added and the solution was again evaporated to dryness in order to remove the organic matter. Although the above steps were not absolutely necessary they reduced to a minimum the amount of material that had to be filtered at the end of this procedure. The remaining residue was heated to dryness in a solution of Na₂CO₃ transforming some of the sulphates into carbonates. Then HCl was again added and evaporated to dryness. This last process transformed the carbonates of the previous step into soluble chlorides. Water was then added to the remaining salt, and the mixture was filtered. The major portion of the solute was NaCl along with some ZnCl₂. The radioactive elements which were present in the solute were in minute quantities.
Figure 1. Absorption curve of water sample.
TABLE I. The Radium Series

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbols</th>
<th>Half Life</th>
<th>Energy of Radiation (Mev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radium</td>
<td>$^{88}$Ra$^{226}$</td>
<td>1600 years</td>
<td>$4.97$</td>
</tr>
<tr>
<td>Radon</td>
<td>$^{86}$Rn$^{222}$</td>
<td>3.825 days</td>
<td>$5.49$</td>
</tr>
<tr>
<td>Polonium</td>
<td>$^{84}$Po$^{218}$(RaA)</td>
<td>3.05 min.</td>
<td>$5.99$</td>
</tr>
<tr>
<td>Lead</td>
<td>$^{82}$Pb$^{214}$(RaB)</td>
<td>26.8 min.</td>
<td>$0.65$</td>
</tr>
<tr>
<td>Bismuth</td>
<td>$^{83}$Bi$^{214}$(RaC)</td>
<td>19.7 min.</td>
<td>$5.50$</td>
</tr>
<tr>
<td>Polonium</td>
<td>$^{84}$Po$^{214}$(RaC')</td>
<td>$1.5 \times 10^{-4}$ sec.</td>
<td>$7.68$</td>
</tr>
<tr>
<td>Thallium</td>
<td>$^{81}$Tl$^{210}$(RaC&quot;)</td>
<td>1.32 min.</td>
<td>$1.80$</td>
</tr>
<tr>
<td>Lead</td>
<td>$^{82}$Pb$^{210}$(RaD)</td>
<td>22.2 years</td>
<td>$0.025$</td>
</tr>
<tr>
<td>Bismuth</td>
<td>$^{83}$Bi$^{210}$(RaE)</td>
<td>4.97 days</td>
<td>$1.17$</td>
</tr>
<tr>
<td>Polonium</td>
<td>$^{84}$Po$^{210}$(RaF)</td>
<td>139 days</td>
<td>$5.30$</td>
</tr>
<tr>
<td>Lead</td>
<td>$^{82}$Pb$^{206}$</td>
<td>Stable</td>
<td>---</td>
</tr>
</tbody>
</table>
figure 2. A Neutron-proton plot of radium and its decay products.
A test of the residue showed that the gamma radiation was approximately equal to that of the original salt placed in the beaker.

A test of the filtrate showed little indication of gamma rays. A drop of the filtrate was evaporated on a slide and placed next to an end-window Geiger tube. An absorption curve, figure 1, shows a plot of the resulting activity in counts per minute against absorbers of aluminum given in mg./cm.² on a semi-logarithmic scale. The curve shows that the beta particles would have been stopped by a 500 mg./cm.² absorber which indicated the presence of particles with energy of about 1.2 Mev (4). The filtrate showed growth in its activity, but due to initial difficulties with the counter the growth curve was not plotted. The filtrate reached its maximum activity after a period of 3 to 4 weeks. After the product had reached a maximum activity there was no decrease in activity during the period of observations taken over the subsequent two months.

From these data and by means of Table I (4) and figure 2 (4) it was concluded that the principal element of the filtrate was probably Pb²¹⁰. The lack of gamma radiation from the filtrate indicated that all elements above Pb²¹⁰ in the series were absent. The 1.2 Mev. beta particles from the filtrate indicated the presence of Bi²¹⁰. Since Bi²¹⁰ has a very short half life and there was no measurable decrease of activity over the period of observation, it was presumed that Pb²¹⁰ was the "source" of the activity present.

For the preparation of the oil solution the same procedure was used as for the water solution up to the point of adding the Na₂CO₃.
Here, instead, a basic solution of ammonium acetate was added to change some of the sulphates into soluble acetates. After evaporating to dryness No. 3 diesel oil was added, and the mixture was then filtered. Although the activity was high enough to be useful, it was still too low for an absorption curve to be plotted. For the oil solution Pb$^{210}$ was assumed to be the "source" of activity because of the chemical reactions which were believed to have taken place (1).

Both of the above methods failed to bring the radium, itself, into solution.

The prepared solutions were colored with dyes in order to leave visible outlines of the droplets after evaporation.
PREPARATION OF SLIDES AND MEASUREMENTS OF SPREAD FACTOR

The slides used to collect the liquid droplets were ordinary microscope cover glasses which were, on the average, 22.1 mm. square. The corners of the slides were rounded by filing in order that they could be placed in the receptacles used in the windowless Geiger tubes (Q-Gas Flow Counter, Manufactured by the Nuclear Instrument and Chemical Corporation).

A repellent, which is used by laundries for water-proofing fabrics, was originally tried as a coating on the slides used to collect water droplets. The purpose of this was to keep the spread factor low. The spread factor is defined as the ratio of the diameter of the base of a droplet resting on a flat surface to the diameter of the droplet in its original spherical shape. It was observed, however, that as the droplet evaporated the diameter of the base became smaller without leaving any visible evidence of its original size. Since the original size of the base is necessary for the calculation of the spread factor, the repellent was discarded.

Vaseline was found to be a much better coating. The vaseline was spread on the clean slides, heated to melting and allowed to cool, giving a smooth surface.

The correction factor (inverse of spread factor) for water droplets resting on a vaseline base was calculated by a method which was revised from that given in an article by K. R. Mey (5). The droplets observed under a microscope from the side appeared to be bounded by a spherical and a plane surface as is shown in figure 3a.

To find the actual radius (r) of the original droplet before it was
caught by the slide, we proceed as follows. Letting the radius of the observed sphere be $R$, the upper half of the sphere will then have for its volume

$$V_1 = \frac{2}{3} \pi R^3$$

To find the volume of the lower portion consider figure 3b where $R$ is the radius of the deposited sphere and $A$ the radius of the base.

The volume of this portion is then

$$V_2 = \pi \left[ -\sqrt{R^2 - A^2} \right]_0^R = \pi \int_0^R \sqrt{R^2 - y^2} \, dy$$

$$V_2 = \pi \left[ -\sqrt{R^2 - A^2} + \frac{(R^2 - A^2) \sqrt{R^2 - A^2}}{3} \right]$$

$$V_2 = \pi \left( \frac{R^3}{3} \right) \left( 2 + \frac{A^2}{R^2} \right) \sqrt{1 - \frac{A^2}{R^2}}$$

The total volume of the droplet on the slide becomes

$$V = V_1 + V_2 = \left( \frac{2}{3} \right) \pi R^3 + \pi \left( \frac{R^3}{3} \right) \left( 2 + \frac{A^2}{R^2} \right) \sqrt{1 - \frac{A^2}{R^2}}$$
Assuming that the original droplet, before it settles on the slide, has a radius \( r \) and a volume \( v \) then

\[
v = v = \frac{4}{3} \pi r^3
\]
or

\[
\left(\frac{4}{3}\right) \pi r^3 = \left(\frac{2}{3}\right) \pi R^3 \left[ 1 + \left(1 + \frac{\frac{A^2}{2R^2}}{1 - \frac{A^3}{R^2}}\right)^{1/3} \right]
\]

Then

\[
r = \frac{R/2^{3/4}}{1 + \left(1 + \frac{\frac{A^2}{2R^2}}{1 - \frac{A^3}{R^2}}\right)^{1/3}}
\]

Dividing both sides by \( A \)

\[
\frac{r}{A} = \frac{R/2^{3/4}}{1 + \left(1 + \frac{\frac{A^2}{2R^2}}{1 - \frac{A^3}{R^2}}\right)^{1/3}}
\]

Now let

\[
\frac{R}{2^{3/4}A} \left[ 1 + \left(1 + \frac{\frac{A^2}{2R^2}}{1 - \frac{A^3}{R^2}}\right)^{1/3} \right] = \Phi(A/R)
\]
or

\[
\frac{r}{A} = \Phi(A/R)
\]

The last equation is an expression that relates the radius \( r \) of the original droplet and the corresponding radius \( A \) of the base of a droplet to a function of \( A/R \). Figure 4 represents a graphical solution of this equation where \( r/A \) or \( \Phi(R/A) \) is a function of \( A/R \).

To find the original radius \( r \) of a droplet measurements were first made at \( a, b, \) and \( c \) respectively by means of the traveling microscope. No measurements were taken at \( d \) because this position would have changed due to the evaporation of the water during the time interval needed for the
Figure 4. Graph of equation for spread factor correction of water drops.
hairline to travel from b to c. From the measurements of a, b, and c the factor \((A/R)\) was determined. By inserting the value \((A/R)\) into the last equation the correction factor \((r/A)\) was found. Since the solution of this equation is plotted in figure 4, the correction factor \((r/A)\) was taken from the curve. The original radius \((r)\) was then found by multiplying the correction factor \((r/A)\) by the radius \((A)\) of the base. For accurate results the correction \((r/A)\) should have been determined for each size of droplet within the range to be investigated. In this investigation, however, only droplets of 500\(\mu\) or larger (true diameter) were measured because the smaller ones would evaporate before any valid readings could be taken. These measurements gave an average value of unity for \(r/A\). The measurements were made at temperatures ranging from 40 to 50 degrees Fahrenheit. For higher temperatures the preceding method does not hold because the droplets spread out more.

For a coating on slides used to collect oil droplets, G. E. Dri-film was recommended, however this was unavailable. A liquid soap solution of 1 part soap to 3 parts water was used instead giving fair results. The slides were dipped into the solution and allowed to dry.

The spread factor was calculated by the same method described in the article by K. R. May (5). This article states that for accurate measurements the spread factors for the sizes of the droplets to be investigated should be calculated for each slide. However for these slides this was not possible because their areas were too small. Instead the droplets (diameters of 50-500\(\mu\)) were measured on slides other than the ones actually
used for spraying. The average correction factor \((r/A)\) for the measurements of oil droplets on the soap coated slides was 0.45. With a soap base the oil droplets had to be measured within 2 or 3 hours after spraying since they spread on standing.
SPRAYING THE RADIOACTIVE SOLUTION ON THE PREPARED SLIDES

The prepared slides were set on pieces of typewriting paper (Hammermill Bond, Wt. 20) about 4 inches square in order to give good overall pictures of the droplet patterns. Though this paper is possibly not the best, it is one of the more readily available types.

The spraying was first conducted inside a sealed chamber but this method was abandoned because the chamber retained the fog (droplets whose diameters are of 50 µ or less) in it. The diameters of these droplets, which were very numerous, could not be measured accurately.

The final spraying operation was conducted outdoors with an ordinary hand spray gun. A slight breeze carried most of the fog away. This more nearly approximated actual field conditions in the applications of insecticides and herbicides. The spray gun itself was held at a distance of from 2 to 4 ft. from the slides which were placed on the paper sheets.
METHODS OF DETERMINING THE TOTAL VOLUME OF SOLUTION DEPOSITED ON SLIDES

Two different methods were used to find the total amount of liquid that was deposited on a slide. One method employed the actual measurements of the sizes of the droplets, and the other, the radioactive properties of the solution.

In the measurement method the sprayed slides were first placed on an ordinary microscope slide which was scratched with lines forming small squares. When the two slides were placed under a microscope the sprayed slide appeared as though it were divided into sections. By measuring the droplets in one section before going to the next, the possibility of counting some of the droplets twice was eliminated. The diameters of the stains were measured to the nearest 10\(\mu\) and were then multiplied by the correction factor. From these corrected diameters the volumes of the droplets were found. The total of these was taken as the volume which was deposited on the slide. This method was used immediately after the spraying of the oil since the oil droplets spread on standing. On some slides the droplets ranging from 50 to 100\(\mu\) in diameter were so numerous that they would have required considerable time to measure. Instead of measuring each of these droplets, on the entire slide, approximations were made by measuring the droplets per unit area over a small portion of a slide, and then multiplying by the total area.

In the radioactive method calibration slides were prepared by depositing the radioactive solutions on the slides by means of micro pipettes which were calibrated for content, one, five, ten, or fifteen
lambdas. A lambda is one one thousandth of a milliter or $10^{-6}$ liter. The droplets were then evaporated, leaving only the residue. Several slides of each amount were prepared.

There were two types of these calibration slides prepared for measuring the total volume of the water droplets; some that had no base at all, and others that had a vaseline coating on them similar to the slides that were sprayed.

On the non-coated slides the pipettes were touched to the slide surface in many different places leaving droplets whose distribution patterns were similar to the slides that were sprayed. These droplets, however, were somewhat larger than those that were encountered under spraying conditions. Although these calibration slides, which were used for measuring the amount of water solution deposited, had droplet distributions similar to those that were deposited by spraying, they did not have the vaseline coating.

On the vaseline coated calibration slides, however, only two or three droplets were deposited because the pipettes could not be placed in contact with the vaseline coating without disturbing it. Only the fifteen lambda pipette was used with these slides because the solution had a tendency to adhere to the outside surface of the pipettes of smaller values and could not all be discharged on to the slides. The droplets on these slides were much larger than those which were sprayed and those deposited on the uncoated calibration slides. Although the coating on these slides, which were also used for measuring the amount of water
solution deposited was the same as the sprayed slides, the droplet
distribution patterns were quite different.

After these slides had been dried their activity was measured by the
end-window counter, the flow counter, and the Landsverk electrometer.
For measurements using the end-window counter the slides were placed
approximately 0.5 cm. from the window of the counter.

The activities of the slides with equal amounts of deposits were
averaged. Figure 5 shows a plot of water solution deposited on the non-
coated slides vs. the activity of its residue in counts/minute (corrected
for background) where the activity was measured by the end-window counter.
Similar curves were plotted using the flow counter and the Landsverk
electrometer. There were no graphs made for the vaseline coated calibra-
tion slides because all of these were prepared by using the 15 lambda
pipette.

For water sprayed slides which were compared with the non-coated
calibration slides and whose activity was measured by the end-window
counter, the total volume of the droplets was found by multiplying the
activity of the residue, in counts/minute (corrected for background), by
the slope of the curve of figure 5. The same procedure was used for
measurements taken by the flow counter and the Landsverk electrometer.

A direct comparison of the activities was used when the volumes of the
water sprayed slides were determined using the coated calibration slides
since there were no graphs plotted.

Errors were introduced for measurements taken by the end-window
Figure 5. Calibration curve for water solution using end window tube.
and the flow counter since the activity of the solution was low. The length of time required to find the activity had to be long in order that the standard deviation (4) could be reduced to a small factor. In the measurements of some slides this factor was as high as 0.15.

The calibrated oil slides were prepared by dipping in the same soap solution used for those on which the oil was sprayed. After the soap solution had dried, the calibrated amounts of oil were deposited in the same way as were the non-coated calibration water slides by touching the pipettes to the slides at many places. The oil was evaporated by an infrared heat lamp. These calibration slides had the same base and similar droplet distribution patterns as the oil sprayed slides. Since the activity of the oil solution was very low the Landsverk electrometer was the only instrument used to measure activity. For determining the amount of oil deposited a curve similar to figure 5 was used.

The methods used to measure the volume of the water solution are summarized as follows:

1. By measuring and counting droplets.
2. By using end-window counter and non-coated calibration slides.
3. By using flow counter and non-coated calibration slides.
4. By using Landsverk electrometer and non-coated calibration slides.
5. By using end-window counter and vaseline coated calibration slides.
7. By using Landsverk electrometer and vaseline coated calibration slides.

The methods used to measure the volume of the oil solution are
summarized as follows:

1. By measuring and counting droplets.

2. By using the Landsverk electrometer and soap coated calibration slides.
RESULTS AND COMPARISON OF MEASUREMENTS

The number of droplets which were measured on the slides varied from approximately 100 to 1000 depending on the amount of solution deposited on the slide. The true diameters of the largest water droplets that were measured were approximately 450 to 550\(\mu\) whereas the largest oil drops had diameters of 300 to 400\(\mu\). The range of the true diameters of the droplets that were deposited most frequently upon the slides was 50 to 150\(\mu\) for water droplets and 100 to 250\(\mu\) for the oil droplets. The corresponding diameters of the stains on the paper ranged from 200 to 350\(\mu\) for the water droplets and from 900 to 1200\(\mu\) for the oil droplets.

The spread factor of the water droplets on paper varied considerably. For droplets of 50 to 100\(\mu\) it appeared to be approximately 1.5, and the droplets of 400\(\mu\) or larger would splatter upon striking the paper. The oil droplets were immediately absorbed upon coming into contact with paper allowing no time to observe for variations of the spread factor in relation to droplet size. The spread factor for the oil droplets on paper was estimated to be between 5 and 7 by comparing the ranges of the droplet sizes determined from the treated slides and their stains on paper.

The results of measurements of four different water sprayed slides and four different oil sprayed slides are given in Tables II and III respectively. The droplet patterns on the paper upon which these slides were placed are given in figures 6a-6d for the water, and figures 7a-7d for the oil droplets. Under the figures the dosages are listed in gallons per acre. For figures 6a-6d the dosages were calculated from the measure-
Table II. Total volume (given in lambdas) of water droplets, listed by methods of measurements.

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Droplet-measurement method</th>
<th>Tracer method</th>
<th>Calibrated amounts on non-coated slides</th>
<th>Calibrated amounts on vaseline coated slides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>End-window counter</td>
<td>Flow counter</td>
</tr>
<tr>
<td>No. 1</td>
<td>0.805</td>
<td></td>
<td>0.87</td>
<td>1.39</td>
</tr>
<tr>
<td>No. 2</td>
<td>1.33</td>
<td></td>
<td>1.52</td>
<td>1.90</td>
</tr>
<tr>
<td>No. 3</td>
<td>1.57</td>
<td></td>
<td>1.41</td>
<td>1.79</td>
</tr>
<tr>
<td>No. 4</td>
<td>3.10</td>
<td></td>
<td>3.06</td>
<td>4.94</td>
</tr>
</tbody>
</table>

Table III. Total volume (given in lambdas) of oil droplets, listed by methods of measurements.

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Droplet measurement method</th>
<th>Tracer method with soap coated calibration slides*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 5</td>
<td>0.126</td>
<td>0.150</td>
</tr>
<tr>
<td>No. 6</td>
<td>0.181</td>
<td>0.157</td>
</tr>
<tr>
<td>No. 7</td>
<td>0.261</td>
<td>0.206</td>
</tr>
<tr>
<td>No. 8</td>
<td>0.343</td>
<td>0.375</td>
</tr>
</tbody>
</table>

*All readings taken by the Landsverk electrometer.
figure 6a. Water droplet pattern for slide No. 1 representing 1.9 gallons per acre.*

figure 6b. Water droplet pattern for slide No. 2 representing 3.3 gallons per acre.*

figure 6c. Water droplet pattern for slide No. 3 representing 3.1 gallons per acre.*

figure 6d. Water droplet pattern for slide No. 4 representing 6.7 gallons per acre.*

*The pictures show the true sizes of the droplet stains. The clear spaces in the centers are where the slides rested.
figure 7a. Oil droplet pattern for slide No. 5 representing 0.33 gallons per acre.*

figure 7b. Oil droplet pattern for slide No. 6 representing 0.34 gallons per acre.*

figure 7c. Oil droplet pattern for slide No. 7 representing 0.45 gallons per acre.*

figure 7d. Oil droplet pattern for slide No. 8 representing 0.82 gallons per acre.*

*The pictures show the true sizes of the droplet stains. The clear spaces in the centers are where the slides rested.
Table IV. The average percentage variation of measurements taken by the different tracer methods as compared with the droplet-measurement method. In all cases the measurements were on the average higher by the tracer methods than by the droplet-measurement method.*

<table>
<thead>
<tr>
<th>Type of calibration slide used</th>
<th>Instrument used to measure activity</th>
<th>End-Window counter</th>
<th>Flow counter</th>
<th>Landsverk electrometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-coated</td>
<td></td>
<td>4</td>
<td>43</td>
<td>16</td>
</tr>
<tr>
<td>Vaseline coated</td>
<td></td>
<td>40</td>
<td>150</td>
<td>230</td>
</tr>
</tbody>
</table>

* e.g., Deposits measured by the end-window counter using the non-coated calibration slides were on the average higher by 4 per cent than the measurements taken by the droplet-measurement method.
ments made by the end-window counter using the non-coated calibration slides. The dosages of oil listed under figures 7a-7d were calculated from measurements made by the Landsverk electrometer.

Table IV gives an overall comparison of measurements made by the tracer methods as compared with the results by the method of droplet measurement for data of Table II. In general, the volumes of the water sprayed slides determined by the tracer method are higher than the droplet-measurement method. From this it became obvious that there were more particles emitted per unit volume from the sprayed slides than from either type of calibration slides.

The coated calibration slides and the sprayed slides were similar except that the droplets on these calibration slides were much larger. This indicated that the deposits left by the large drops were absorbing more particles than those left by the small ones.

To test for self absorption two slides were prepared each having the same amount of water solution deposited upon them. However, one slide had many droplets, and the other, only one. The slide with one drop had a very thin coating of water repellent (used for water proofing fabrics) to keep the drop from spreading. The activity as measured by the flow counter of the slide with one droplet was 55 per cent of the activity of the slide with many droplets. The activities of the slides were measured again using the end-window counter along with a 3.264 mg./cm.² aluminum absorber. The window of the counter (equivalent to 2.7 mg./cm.² mica) and the aluminum absorber were sufficient to absorb the alpha particles of
Po\(^{210}\) but not the beta particles of Bi\(^{210}\). Under these conditions the activity of the slide with one drop was 93 per cent of the activity of the slide with many drops. The results of these tests showed that the deposits of the larger droplets absorbed many more alpha particles than the smaller ones. On the other hand, the beta particles were not affected nearly as much by the differences in the sizes of the droplets.

The measurements of the water sprayed slides using the non-coated calibration slides were lower than the measurements using the coated calibration slides. Therefore, the number of particles from these slides (per unit volume of deposit) must have been larger than the number from the coated calibration slides. These additional particles were due to the greater backscattering of the beta particles. There were also more alpha particles from these calibration slides since the droplets on these slides were smaller than those on the coated calibration slides.

The corrected overall measurements for the volumes of the oil droplets by the tracer method were approximately 4 per cent higher as compared with the method of droplet measurement. The measurements by the tracer method were not consistently high, but varied above and below the values taken by the droplet-measurement method. Because of this, and since the geometry of the oil calibration and sprayed slides were similar it could not be determined which of the two methods led to the greater error.

Since the errors of this investigation were mainly due to the tracer we are led to believe that by using a tracer with more nearly homogeneous emission much better measurements would have resulted.
LITERATURE CONSULTED


AUTHOR
Itoh, Robert

TITLE
Investigation of droplet-distribution patterns in sprays by means of radioactive tracers

DATE DUE
May 20, 1953

BORROWER'S NAME

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