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EVALUATION OF THE SINGLE-OPERATION ALPHA, COUNTER (Information Report)
EVALUATION OF THE SINGLE-OPERATION ALPHA COUNTER

(Information Report)

BY

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ABSTRACT
The single-operation alpha counter, designed primarily for counting low-level alpha samples prepared by plating activity onto metal cylinders, was evaluated as a possible replacement for the parallel-plate counters now used to count activity plated on disks. Each cylinder is closed at one end, so that all activity plated on it is on an outside surface which faces the sensitive volume of the chamber, and the total activity of the plate can be determined by a single count. Each side of the disk must be counted separately in the parallel-plate counter, and the edge may be counted twice. Results from about 300 cylinders and 300 disks ranging in activity from 0 to 80 counts per minute were compared. The single-operation counter was found to be capable of giving results at least as good as those obtained with the parallel-plate counter and in half the counting time. The following changes were suggested in the final model of the instrument: (1) redesign of the chamber for more effective decontamination, (2) design of a tool to be used for inserting and removing cylinders, (3) addition of a pressure gauge to the chamber, and (4) an improvement in the method of sealing the chamber to speed operation and insure a better seal.

INTRODUCTION
The single-operation alpha counter was developed primarily for counting low-level alpha samples prepared by plating activity onto metal cylinders. It was intended as a possible replacement for the parallel-plate counters now used to count activity plated on disks.

The single-operation counter uses an inert-gas-filled ionization chamber designed to accept small, cylindrical samples. Each cylinder is closed at one end, so that all activity plated on it is on an outside surface which faces the sensitive volume of the chamber, and the total activity of the plate can be determined by a single count. In a parallel-plate counter, each side of the disk must be counted separately. The edge of the disk may be counted twice, necessitating an edge correction; this introduces an uncertainty into the final result, particularly since the activity does not necessarily plate uniformly on the disk. The single-operation counter should give the same statistical precision in one-half the time and eliminate the uncertainty due to edge effect.

The objective of this investigation was to evaluate the single-operation counter as a possible replacement for the parallel-plate counter in counting plated samples. This involved comparing the precision obtainable with the two types of counters and recommending changes in design for ease of operation or more accurate results.

GENERAL METHOD
Plating procedures now in routine use were followed to plate a series of cylinders and disks from known concentrations of polonium-210 in hydrochloric acid. The amounts plated on cylinders and disks ranged from 0 to about 80 counts per minute. For each disk plated, a cylinder was plated from an equal amount of the same solutions under conditions as nearly identical as possible. The disks were counted in a routine manner on the parallel-plate counters in the "B" Building for 40 minutes (20 minutes for each side). The cylinders were counted for 20 minutes in the single-operation counter. Results from both types of instruments were then examined for precision and activity levels.

METHOD AND DISCUSSION OF RESULTS - 5 TO 80 COUNTS PER MINUTE
The first part of the plating and preparation of solutions was done in the "B" Building. Each disk was plated from 50 milliliters of solution of polonium in one-half normal hydrochloric acid in a paper cup, the disk being submerged at the side of the cup with a glass stirring rod at the center. The cup then was rotated for two hours.
Of the first 50 cylinders plated, 25 were plated while positioned at the side of the cup, and 25 were plated by replacing the glass stirring rod at the center with the cylinder. Results (Table I) showed that 70 per cent of the activity was plated on cylinders in the side position, while 75 per cent was plated on cylinders in the center position. The side position was used for the remainder of the "B" building plating.

Results of this work are summarized in Table I. The plated activity on the cylinders as counted in the single-operation counter was, in every case except one, less than that on the corresponding group of disks. This was to be expected since the edge effect would result in an erroneously high count on the disks. In the one case where the cylinders counted higher than the disks (Table I, Reference Date 9/15/52), it would seem that there was an error in the preparation of the solutions since more activity was plated than the solutions were believed to contain.

### Table I

**Counting Results From Disks and Cylinders**

<table>
<thead>
<tr>
<th>Reference Date</th>
<th>Activity in Solution</th>
<th>No of Samples</th>
<th>Sample CTR/MIN in Sample</th>
<th>CTR/MIN in Solution</th>
<th>Std Deviation Due to Counting Statistics Alone</th>
<th>Counting Time Per Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/11/52</td>
<td>95 cts/min</td>
<td>25 cylinders</td>
<td>74.62</td>
<td>0.79</td>
<td>4.76</td>
<td>2.62</td>
</tr>
<tr>
<td>8/11/52</td>
<td>95 cts/min</td>
<td>25 cylinders</td>
<td>71.65</td>
<td>0.75</td>
<td>5.72</td>
<td>2.64</td>
</tr>
<tr>
<td>8/11/52</td>
<td>95 cts/min</td>
<td>11 cylinders</td>
<td>76.65</td>
<td>3.12</td>
<td>2.55</td>
<td>2.00</td>
</tr>
<tr>
<td>8/11/52</td>
<td>95 cts/min</td>
<td>25 disks</td>
<td>80.35</td>
<td>0.64</td>
<td>5.64</td>
<td>2.43</td>
</tr>
<tr>
<td>8/26/52</td>
<td>17.68 cts/min</td>
<td>24 cylinders</td>
<td>12.64</td>
<td>0.72</td>
<td>5.94</td>
<td>2.39</td>
</tr>
<tr>
<td>8/26/52</td>
<td>17.68 cts/min</td>
<td>24 cylinders</td>
<td>14.41</td>
<td>0.82</td>
<td>10.16</td>
<td>5.33</td>
</tr>
<tr>
<td>9/15/52</td>
<td>11 cts/min</td>
<td>23 cylinders</td>
<td>12.79</td>
<td>1.11</td>
<td>10.48</td>
<td>6.41</td>
</tr>
<tr>
<td>9/15/52</td>
<td>11.56 cts/min</td>
<td>23 disks</td>
<td>11.53</td>
<td>1.00</td>
<td>14.05</td>
<td>5.59</td>
</tr>
<tr>
<td>9/22/52</td>
<td>10.77 cts/min</td>
<td>25 cylinders</td>
<td>8.05</td>
<td>0.75</td>
<td>15.16</td>
<td>9.19</td>
</tr>
<tr>
<td>9/22/52</td>
<td>10.77 cts/min</td>
<td>1 cylinder</td>
<td>10.23</td>
<td>11.73</td>
<td>8.02</td>
<td>2.00</td>
</tr>
<tr>
<td>9/22/52</td>
<td>10.77 cts/min</td>
<td>25 disks</td>
<td>10.12</td>
<td>0.94</td>
<td>13.24</td>
<td>5.92</td>
</tr>
</tbody>
</table>
There seemed to be little difference in the statistical precision between counts on samples within a group, whether they were plated on disks or on cylinders. The standard deviation for both disks and cylinders was significantly more than expected from counting statistics alone. In order to determine whether this was caused by differences between supposedly identical samples or to counter instability, a single cylinder from each of two groups was counted repeatedly in the single-operation counter. In both cases, the standard deviation decreased to approach the deviation expected from counting statistics.

This would indicate that there were significant differences between samples whose counting rates theoretically should be identical. Three possible reasons for this were presence of background on blank disks and cylinders, nonuniformity of plating solutions, and differences in plating efficiency from sample to sample. The backgrounds of blank cylinders had been measured throughout the work; the backgrounds were getting progressively higher, ranging from 0.5 to 3.0 counts per minute on the last group measured. Evidently, the blanks were being contaminated in the "B" Building cleaning process, since blanks which had not been cleaned had negligible backgrounds. There was also some indication of nonuniformity of plating solutions, as in the instance already cited. It would have been desirable to check the plating efficiency by assaying the depleted solutions, but this was found to be impractical in the low levels of activity with the counting instruments available at the time.

It will be noted that the expected per cent deviations due to statistics alone were always higher for the cylinders than for the disks of comparable specific activity. This was because the background of the single-operation counter ranged from 0.60 to 3.13 counts per minute while the backgrounds were kept extremely low on parallel-plate counters. This had a significant effect on counting statistics in the low levels tested. The design of this experimental model of the counter made decontamination difficult.

**METHOD AND DISCUSSION OF RESULTS - 0 to 5 COUNTS PER MINUTE**

The remaining levels of activity at which the counter needed to be checked were in the range of from 0 to 5 counts per minute. The remainder of the work was done in the "I" Building. First, each of 100 cleaned, blank disks was counted for 40 minutes on a parallel-plate counter and 100 cleaned, blank cylinders were counted on the single-operation counter. The blanks were found to have no appreciable background, and the counting precision was good for both types of instruments (Table II).

The plating solutions were prepared by diluting hydrochloric acid solutions of polonium with distilled water or with urine to one normal. Fifty disks and fifty cylinders were plated from the distilled-water solution, and another fifty disks and fifty cylinders from the urine solution. Extreme care was taken in assaying the polonium in solution accurately, in diluting accurately, and in pipetting exactly 50 milliliters into each plating cup. For reasons of expediency the center plating position was used. Each sample was plated for two hours.

The precision obtained with the single-operation counter with these samples, while acceptable, was not as good as the precision obtained with the parallel-plate counters. A single cylinder counted 50 times had almost the same standard deviation per observation (Table II) as the group of 50 samples counted once each: this indicated that the variations were in the counter in this instance and not between samples. After the blanks were counted and during the counting of these low-level samples, variations were noted in the apparent background of the single-operation counter that were not present during the rest of the work. It was concluded that circuit difficulties had developed which could be corrected. It was discovered later that the silver-solder joints of the chamber contained pinholes. This would explain many of the difficulties encountered with the single-operation counter.
### TABLE II

**COUNTING RESULTS FROM DISKS AND CYLINDERS**

**RANGE OF 0 TO 5 COUNTS PER MINUTE**

<table>
<thead>
<tr>
<th>REFERENCE DATE</th>
<th>ACTIVITY IN SOLUTION (cts/min)</th>
<th>NO. OF SAMPLES</th>
<th>SAMPLE (av cts/min)</th>
<th>CTS/MIN IN SAMPLE</th>
<th>CTS/MIN IN SOL.</th>
<th>EXPECTED DEVIATION DUE TO COUNTING STATISTICS</th>
<th>COUNTING TIME PER SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/7/52</td>
<td>0 (BLANKS)</td>
<td>100 CYLINDERS</td>
<td>-0.04</td>
<td>0.75</td>
<td>0.97 cts/min</td>
<td>0.37 cts/min</td>
<td>20</td>
</tr>
<tr>
<td>10/7/52</td>
<td>0 (BLANKS)</td>
<td>100 DISKS</td>
<td>0.23</td>
<td>0.74</td>
<td>0.25 cts/min</td>
<td>0.25 cts/min</td>
<td>40</td>
</tr>
<tr>
<td>10/31/52</td>
<td>5.46 IN URINE</td>
<td>50 CYLINDERS</td>
<td>4.11</td>
<td>0.75</td>
<td>24.33 PER CENT</td>
<td>12.07 cts/min</td>
<td>20</td>
</tr>
<tr>
<td>10/31/52</td>
<td>5.46 IN H2O</td>
<td>50 CYLINDERS</td>
<td>4.65</td>
<td>0.74</td>
<td>18.47 PER CENT</td>
<td>12.24 cts/min</td>
<td>20</td>
</tr>
<tr>
<td>11/17/52</td>
<td>5.01 IN H2O</td>
<td>1 CYLINDER</td>
<td>3.94</td>
<td>0.74</td>
<td>18.49 PER CENT</td>
<td>12.24 cts/min</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(COUNTED 50 TIMES)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/31/52</td>
<td>5.46 IN URINE</td>
<td>50 DISKS</td>
<td>4.61</td>
<td>0.84</td>
<td>14.97 PER CENT</td>
<td>10.41 cts/min</td>
<td>40</td>
</tr>
<tr>
<td>10/31/52</td>
<td>5.46 IN H2O</td>
<td>50 DISKS</td>
<td>5.15</td>
<td>0.94</td>
<td>13.98 PER CENT</td>
<td>10.10 cts/min</td>
<td>40</td>
</tr>
</tbody>
</table>

**CONCLUSIONS**

The conclusions drawn were that the single-operation counter is capable of giving results at least as good as those obtained from the parallel-plate counter and in half the counting time. Its use affords the opportunity of counting plated samples at lower counting rates than are now practical.

We would suggest the following changes in the final model of the instrument.

1. Redesign of the chamber for more effective decontamination.
2. Design of a tool to be used for inserting and removing cylinders.
3. Addition of a pressure gauge to determine (a) when a vacuum has been reached and (b) when gas has filled the chamber to atmospheric pressure.
4. An improvement in the method of sealing the chamber to speed operation and insure a better seal.
REFERENCES


3. The plating, preparation, and assay of solutions carried out in the "B" Building were performed by I. Zuroweste.

4. The assay and preparation of solutions carried out in the "I" Building were performed by J. J. Dauby.

5. The "I" Building plating was done by N. Poling.