An Improved, Portable pH Apparatus.

By

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In the previous paper\(^1\), the author described a portable pH apparatus with micro-analytical electrode and saturated calomel electrode, and ever since the apparatus has been used in various field of research as well as in the industry. Lately the due improvement* was made on the apparatus as it will be described in detail in this paper.

Description of the Apparatus.

1. Wiring of the apparatus:
The wiring of the apparatus was changed somewhat as shown in Fig. I.

Fig. I.

Wiring of the Apparatus.

Connection Diagram of New Type Itano's pH Apparatus

1) ITANO, A., Berichte des Ōhara Instituts etc., Bd. IV, Heft 1, 19, 1929.
* Cooperated by Mr. H. KONDO, (Rigakushi) of Research Department, Shimazu Seisakusho, Kyoto, Japan.
Examining the new wiring in conjunction with the old one, it will be noted that the galvanometer and millivoltmeter are combined into one piece which is manipulated by means of a newly constructed double-throw switch. Also an improvement was made on the galvanometer key. The entire apparatus appears as it is shown in Plate XXXIX.

2. Manipulation of the apparatus:
The treatment of sample and the connection of chain are the same with the old apparatus. After the chain is arranged, the procedure is carried out as follows:

1) The commutator (+) is placed so that a connection is made to either end of the chain.
2) The short circuit key is taken out and the needle of the galvanometer is adjusted to zero.
3) The dry battery is connected with due caution as to +, - post.
4) The main switch is put in and the voltmeter is placed in the circuit by means of the double-throw switch as the position indicated on the key 'Volt'; then the 'Rough Adjust' is turned and ascertain that the galvanometer needle swings over the entire range of 400; if it fails to do so even the resistance adjust reaches to 10, the battery should be changed.
5) Then the double-switch is turned to 'Galv' and see if the needle rests on zero; the key $R_1$ is pushed down watching the movement of the needle and the 'Rough Adjust' is turned to get the balance; if no balance is obtained by putting in entire 'Rough Adjust', then the commutator should be turned to the other direction. Again the key $R_1$ is tapped manipulating 'Rough Adjust' until the approximate balance is obtained; then the resistance $R_0$ is tapped and the balance is obtained by the aid of 'Fine Adjust'.
6) After the balance is obtained, the double-throw switch is turned to 'Volt' and the voltage is read off from the scale.
7) From the millivolts thus obtained, the corresponding $p_H$ value can be found in the $p_H$ Table\(^1\). If the temperature correction is desired, the millivolt read on the scale is multiplied by the temperature factor and then the corresponding $p_H$ value is found since the $p_H$ value given in the Table is calculated at 18°C.

For example:
At 25°C, if the millivoltmeter indicates +111 m.v., using the quinhydrone electrode against the saturated calomel electrode, then the $p_H$ value can be obtained from the Table as follows;

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\[ +111 \times 0.9870^* = 109.5 \text{ m.v.} \]
\[ \text{PH} = 5.97^+ \]

Precautions:
1. To bring the needle to rest from swinging, the short circuit key may be inserted temporarily: (It should be taken out while the determination is carried on.)
2. The short circuit key is kept in place when the apparatus not in use.

Merits of the improved apparatus:
The merits of this apparatus may be summarized as follows:
1. The sensitivity of the apparatus increased over the old type.
2. It is easier to manipulate and the result can be read off more accurately.
3. It is more solidly constructed so that it stands against the transportation much better.

Experimental.

The accuracy of the improved \( \text{PH} \) apparatus was checked against the Type K Potentiometer of Leeds and Northrup Co., taking seven buffer solutions. The results are given in Table I.

<table>
<thead>
<tr>
<th>No. of Solution</th>
<th>Apparatus.</th>
<th>Type K</th>
<th>Itano.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>7.96</td>
<td>7.97</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>7.42</td>
<td>7.42</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>7.16</td>
<td>7.19</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>6.17</td>
<td>6.23</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>5.90</td>
<td>5.96</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>5.30</td>
<td>5.31</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>3.55</td>
<td></td>
</tr>
</tbody>
</table>

As Table I. indicates that very close results were obtained by these two types of apparatus. A slight difference is found among the figures at the hundredth place while some of them are exactly the same.

* ITANO, A., Loc. cit. 203. (the middle column.)
† ibid 229.
Summary.

The contents of this paper may be summarized as follows:

1. An improved type of apparatus for determination of hydrogen ion concentration is described.
2. By the improved type, the results which are closely comparable with those obtained with Type K Potentiometer were obtained.
3. The new type is more solidly built and resists the damage which may be brought about in course of transportation and handling.
4. The sensitivity of the new type is increased over the old type.
PLATE XXXIX.

Improved Type Itano's pH Apparatus.