OPERATION AND
SERVICE GUIDE
O-680
AUG. 1992

pH METER
EXPANDABLE SCALE TABLE TOP
MODEL: 140 PRICE CODE NO. 56-0034

Refer to Bulletin A-303

GENERAL INFORMATION

Series 140 pH meters are designed for measuring pH and also other electrochemical potentials. Consequently, there are several modes of operation possible in addition to pH. The 0 to 14 scale may be used for either pH or 0 to 1400 millivolts depending on the function switch position. The lower scale is used only during expanded scale measurements. Some models also have a logarithmic scale which may be calibrated for direct reading of ion concentration. Controls to accomplish these operations are on the front panel.

Electrode connections are on the rear of the base. Certain models also have recorder and current source connections located here.

These are line operated instruments requiring 115 volts AC power. They will operate over the range of 100 to 130 line voltage. Only five watts is required.

OPERATION

Plug the power cord into a grounded outlet. This is important not only from the standpoint of safety but also provides ground for shielding of the electronics.

Connect the electrodes to the appropriate connectors on the rear panel. The larger BNC type connector is for glass or combination electrodes. The smaller pin jack is for a reference electrode which is required when using a glass electrode as described in the electrode instruction section of this manual.

STANDARDIZATION

Turn on the power and calibrate the electrode with a buffer solution. This is accomplished by first setting the temperature compensator knob on the front panel to the temperature of the buffer as necessary. Dip the electrode tip one to four centimeters below the surface of the solution. Swirl the solution or stir with the electrode until a constant reading is obtained. While continuing the movement, adjust the water or the solution to be tested. Dip the tip of the electrode one to four centimeters below the surface of the sample solution and read the meter. Do not allow solution to enter the upper vent hole of a refillable electrode.

The preceding procedure is general for either regular or expanded scale. Use of the expanded scale requires an estimate of the appropriate range for the scale. Once the expanded scale switch has been turned on, any two pH range may be selected for the 0-1-2 scale.

For example, it may be 3.00 to 5.00 pH range with scale 0 being pH 3.00, 1 being pH 4.00 and 2 being pH 5.00. Or it may be a 6.00 to 8.00 range with scale 0 being 6.00, 1 being 7.00 and 2 being 8.00. As another example, if a range of 7.00 to 9.00 is desired the electrode should be calibrated with a buffer between 7 and 9. If a buffer of 7.00 were used for this last example, the meter would be calibrated to 0 on the lower scale. Scale 1 would be 8.00 and scale 2 would be 9.00. pH 7.00 buffer could also be used to obtain a range of 5.00 to 7.00. Other buffers can be used to obtain other ranges for the expanded scale.

During a test the BNC electrode connector should not be touched as an error may result. This connector is at electronic circuit ground potential which may be a few millivolts different from the potential of the solution being tested. The voltage difference is generated by the reference electrode.

SLOPE CORRECTION

Electrodes may be encountered which do not produce the theoretical voltage change for a unit of pH change. This is called slope error. It may be determined by measuring two freshly prepared buffers of different pH. If the response is not correct, the slope error may be corrected by turning the temperature knob. A lower temperature setting will increase the meter movement. The difference between the actual solution temperature and the temperature knob setting may be considered the slope error. This slope error for a specific electrode may be applied to future measurements at other temperatures. Certain pH meter models have a slope correction knob calibrated in percent error. The slope error is frequently due to foreign ions in the reference electrode junction of solution.

ELECTRODES

There are three types of electrodes available. These are glass, reference, and combination glass/reference. Combination electrodes are usually supplied with the instrument.

The glass electrode produces a voltage as a result of the pH difference across a thin glass membrane. This membrane is in the form of a bulb at the lower end of the tubular body of the electrode. A silver wire coated with silver chloride makes an electrical connection to buffer solution on the inside of the membrane. In use, the outside of the electrode is immersed in buffer or sample solution. Electric current passes through the thin pH glass wall. Electrical connection to the buffer or sample is made through a reference electrode. The reproducibility and stability of the pH reading is dependent on the reference electrode. Originally, these two electrodes were separate and many users prefer this arrangement. However, today the more common arrangement for laboratory applications is with the two electrodes combined in a combination electrode with the reference electrode surrounding the glass pH electrode. This arrangement has advantages in convenience and requires less sample.

GLASS ELECTRODE

These instructions are for either a glass pH electrode or the glass electrode portion of a combination electrode.

For first time use or after long storage, soak the tip in tap water or buffer for five to thirty minutes, depending on the accuracy desired. The longer period is necessary if an accuracy of 0.001 pH is desired.

It is important that the water at the surface of the pH glass bulb have the same composition as the entire sample. Therefore, the bulb surface must be clean. Sample must flush away prior solution adequately to produce the desired pH accuracy.

If the electrode is used in oily solution, it will be necessary to periodically clean the electrode's pH sensitive surface with a towel. If detergent is necessary, the electrode should be rinsed thoroughly since a surface film will interfere with correct operation.

The output voltage of a glass electrode is approximately the same as a reference electrode at pH 7.0.

The pH at which there is no voltage difference between the glass and reference electrode is zero asymmetry potential. The glass electrode is positive with respect to the reference electrode at lower pH values and negative at higher pH values.

MAINTENANCE

Case exterior finish may be maintained by cleaning with a damp rag wetted with detergent. Spray type window cleaning materials are also effective but must never be allowed to wet the electrode connector.

The electronics are entirely solid state which essentially eliminates maintenance. All wearing parts such as potentiometers are standard type and available from SERFILCO. The power supply and amplifier are in the base. The electronics is accessible after removing the four screws on the sides of the base. The cover should be lifted vertically. When returning the cover into place make certain the posts do not hit the transformer. Access to the meter is obtained by removing the four screws on the rear of the cover.

In the center of the black portion of the meter face there is an adjustment screw. This has been set to obtain no meter movement when switching between plus and minus millivolts. Do not adjust this screw except for this purpose.

If it is suspected that the instrument calibration is not correct, use the following procedure to calibrate the pH scale. The basic adjustment will be positioning the temperature compensator knob on its shaft. The voltage output of any pH electrode is directly proportional to the absolute temperature. At a higher sample temperature, the voltage change per solution pH change is higher and the temperature compensator will reduce this voltage change on the meter. A theoretically perfect electrode will produce 0.05916 volts change for each 1.000 pH change at 25°C. Calibration of a pH meter involves injecting known voltage into the instrument BNC electrode connector and adjustment of the temperature compensator to produce the correct meter reading. Make certain that the source of calibration voltage has adequate accuracy because some of the commonly used pH calibration boxes have considerably less accuracy than the pH meter being calibrated. The procedure is to turn on the power, inject 0.00 volts and adjust the meter to pH 7.00 by means of the calibration knob. Inject +0.414 volts and make the meter read 0.00 pH by turning the temperature knob. Repeat, then finally loosen the set screw for the temperature knob, set to 25°C and tighten the set screw.

ELECTRODE

Of all the parts of this instrument, the electrodes will require the most service. The two most critical service details are the cleanliness of the pH sensitive glass bulb and the cleanliness of the reference electrode junction. To clean, use a wet paper towel and wipe the glass bulb or junction several times. Detergent may be used to clean electrodes severely contaminated with oil or grease. During this process, the electrode must be held vertical to ensure filling solution flow out of the junction.

The refillable electrodes have a 3 millimeter hole in the side about 15 millimeters below the plastic cap. The solution level should be maintained within 10 millimeters of this hole. Except for the calomel electrode, only 4 molar potassium chloride saturated with silver chloride should be used to fill this reservoir. The calomel electrode requires saturated potassium chloride solution.

The procedure for refilling a reference electrode is to first open the vent hole. With the electrode held at an angle, touch the tip of the filling solution bottle against the vent hole and squeeze the bottle but allow for displaced air at vent.

If sample is allowed to enter the vent hole of the electrode, it may become permanently damaged. Evidence of this would be that an electrode which had operated correctly would fail to come to the buffer pH on the 0 to 14 scale even though the standardization knob were at one end of its travel.

If sample is allowed to enter the vent hole of the electrode, the filling solution should be removed and the interior flushed with filling solution. The solution may be drawn out by capillary action using a paper towel. Hold the electrode horizontal with the vent hole on the bottom. Roll the edge of a paper towel to a point and insert the point in the vent hole. After rinsing the electrode refill it with the correct type of filling solution.

Samples containing materials which react with silver may produce an error on the signal from the silver-silver chloride reference electrode. Evidence of this would be slowly drifting pH reading when the electrode is in sample, but a steady reading when the electrode is in buffer. Examples of interfering materials are proteins and some heavy metal plating solutions. A glass/calomel electrode is recommended for these applications.

SILVER CHLORIDE REFERENCE ELECTRODE

When a new electrode is first being placed in service, wet the entire outside surface except top cap in tap water. Remove the lower rubber cap which is for storage only. Clean the junction. Slide the upper rubber sleeve down sufficiently to allow air to enter the vent hole covered by the sleeve. The vent hole must remain open during tests. Soak the electrode tip in water for five to thirty minutes depending upon the accuracy required. This soaking is necessary to allow the KCl flow from inside the electrode to become constant.

Periodically, it will be necessary to refill the reservoir with solution. Use only 4M potassium chloride saturated with silver chloride. For one to three hours after addition of solution the pH signal may be low and drifting up. Periodic standardization with buffer will be necessary during this period. The internal solution should be maintained within one centimeter of the vent hole.

For short strorage of the electrodes (up to one week) the electrode may be placed in a beaker containing about two centimeters of water. Leave the vent hole open. For long storage (over one week) the electrode should be filled with KCl to just below the filling hole and all rubbers should be placed in the original positions as when the electrode was received. The electrode may then be placed back in the box and stored.

Silver-silver chloride is a widely used reference electrode because it is rugged and simple. Its voltage is reliable over a broad temperature range. If the electrode is allowed to run dry it can be refilled with little chance of being damaged. It has the disadvantage of being sensitive to flow or pressure of sample against the junction. If the sample is stirred the pH meter reading may fluctuate as much as 0.3 pH. Certain ions such as proteins or heavy metals may change the electrode voltage.

The silver-silver chloride cell in the electrode consists of a silver wire coated with silver chloride. The silver chloride on the wire is in equilibrium with the surrounding potassium chloride solution. Consequently, for stable operation the electrode must be filled worth potassium chloride saturated with silver chloride.

CALOMEL REFERENCE ELECTRODE

All operating and service instructions are the same as for the silver chloride reference electrode with the exception of the filling solution. Saturated potassium chloride solution must be used. Do not use solution containing silver chloride.

The calomel electrode is considerably more stable than the silver-silver chloride electrode. The effect of solution motion is only 1/10th of that for the silver-silver chloride electrode. There is no interference from proteins or heavy metals. It does have a limited temperature range. If allowed to run dry a bubble may enter the calomel cell and this can be removed by drawing a vacuum on the electrode vent . Silver ion must not be in the filling solution and only pure potassium chloride solution should be used to fill the calomel electrode.

COMBINATION ELECTRODE

A combination electrode consists of a glass electrode and a reference electrode in a single probe. It has the advantage of requiring less sample and also of being easier to clean, than two separate electrodes. Since either a silver-silver chloride or a calomel cell may be used, it is important that the correct procedure be followed for maintaining the electrode. Make certain that only filling solution containing silver is used with a silver chloride reference. Also make sure that filling solution containing silver never enters a calomel reference reservoir.

SEALED COMBINATION ELECTRODE

Sealed combination electrodes have the usual construction for the glass cell. The reference cells contain potassium chloride saturated with silver chloride and thickened with a gel. The junction is porous ceramic. There is no vent hole for the reference cell. The gel reduces the solution flow rate sufficiently so it will last for many months depending upon the type of service.

If temperature changes occur during a series of tests, solution may be drawn into the reference junction. This may cause the calibration to drift. For this reason a sealed electrode should be carefully evaluated for any application requiring accuracy better than 0.2 pH. Such evaluation should include electrode response tests with two buffers of difference pH, before and after sample tests.

The correct procedure for using a plastic body sealed electrode is to stir the solution with the electrode. First stir the buffer and calibrate to buffer pH. Next stir some ion free water (distilled or deionized). Finally stir the sample and read the meter. The reason for this procedure is that the reference junction is inside the electrode guard behind the glass bulb and good circulation in this cavity is necessary.

ELECTRODE TEMPERATURE

The pH calibration of all glass electrodes is dependent on temperature. Therefore, it is necessary to compensate for temperature of the electrode. A temperature control knob is on the front panel for this compensation. For measurements within one pH of the buffer and between 10° and 40°C, the temperature correction error is below 0.1 pH. Consequently, for this type of measurement, the temperature control may be left at 25°C. For measurements at greater than one pH from the buffer and requiring accurate results, the temperature compensation knob must be adjusted. Set this knob to the temperature of the buffer when standardizing the electrode.

For best accuracy, the buffer temperature and the sample temperature must be the same. One method of accomplishing this for field work is to immerse the bottle of buffer in the sample for a few minutes.

All glass electrodes have a temperature coefficient proportional to the absolute temperature. The voltage produced by the electrode is greater at higher temperatures. For example, if an electrode is calibrated with buffer at pH 7.00 and a temperature of 25°C, each one pH change will produce an output change of 59 millivolts. At 50°C, each one pH change will produce an electrode output change of 64 millivolts. The meter temperature knob adjusts the number of millivolts change at the input connector required to make a one pH change on meter. The instrument temperature compensation knob is essentially a slope control or in electronic terms, an amplifier gain control.

BUFFER SOLUTIONS

Buffer solutions for calibrating the electrode are available from your SERFILCO dealer, or may be prepared from the instructions provided in many chemical handbooks. For best test accuracy, the buffer pH should be as close as possible to the sample pH. Buffer solution pH may change with time due to absorption of carbon dioxide. Solution stored in plastic bottles for more than a year should be suspect and checked against fresh buffer. Deterioration is greatest for high pH buffers such as borate.

All buffer solutions change pH with a change in temperature. The pH vs. temperature for common buffer solution is shown on the following page.

TEMPERATURE °C	pH 1.68 TETROXALATE	pH 4.01 PHTHALATE	pH 7.00 PHOSPHATE	pH 9.18 BORATE
0	1.67	4.01	7.12	9.46
5	1.67	4.01	7.09	9.39
10	1.67	4.00	7.06	9.33
15	1.67	4.00	7.04	9.27
20	1.68	4.00	7.02	9.22
25	1.68	4.01	7.00	9.18
30	1.69	4.01	6.99	9.14
35	1.69	4.02	6.98	9.10
40	1.70	4.03	6.98	9.07
45	1.70	4.04	6.97	9.04
50	1.71	4.06	6.97	9.01
55	1.72	4.06	6.98	8.99
60	1.73	4.10	6.98	8.96
70		4.12	6.99	8.92
80		4.16	7.00	8.88
90		4.20	7.00	8.65

Sample pH will also change with temperature depending on the composition. For accurate results it is important that buffer and sample be at the same temperature. Conversely, if an accuracy of only 0.2 pH is required, buffer pH drift with temperature generally may be ignored.

Refer to Master Price List F-700-1

ACCESSORIES	PRICE CODE NO.
Electrode, glass, general purpose, for use with pH meters 100, 140, 142, 101, 113, 131, 132	56-0400
Sealed, disposable, plastic sheathed, non-breakable, silver-chloride reference with ceramic junction, for use with pH meters 100, 140, 142, 101, 113, 131, 132	56-0412
Refillable version of 56-0412. For use with pH meters 100, 142, 101, 113, 131,& 132	56-0413
8mm, economy glass combination, refillable. For use with pH meter model PA-10	56-0402
Sealed, disposable, plastic sheathed, nonbreakable, silver-chloride with ceramic junction, for use with pH meters PA-10	56-0403
Glass, 8mm, refillable calomel, for pH meter model PA-10	56-0306
NOTE: All electrodes supplied with BNC connectors unless specified otherwise	
Buffer solution - 7.00 pH 2 oz.	56-0404
Buffer solution - 7.00 pH pint	56-0405
Electrode filling solution; siver/silver chloride electrode	56-0406
Carrying case for model PA-10 meter	56-0407
Electrode stand for models 100, 140, 142, 101, 131, 132, 133	46-0408
Electrode holder for use with 56-0408	56-0409
Battery charger for model 100 meter, complete with 6 batteries and meter connector - must be ordered with meter	56-0033
Adaptor for 230 Volt supply - for use with pH meters 140, 142, 101, 113, 111, 112, 131, 132, 133	56-0414

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