pH RECORDER

OPERATING
INSTRUCTIONS AND
SERVICE GUIDE
O-0690E
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MODEL: 400 PRICE CODE NO. 56-0046

Refer to Bulletin A-302

DESCRIPTION

Model 400 pH recorder is designed to continuously record the pH of solution. A complete system will require an electrode and possibly an extension cable. Panel mounting hardware is included with the recorder.

The instrument has a power switch and fuse on the rear. Control knobs for electrode calibration (right) and temperature compensation (left) are on the front panel. A sliding access window permits adding notes to the chart. The front door swings down and provides access to the chart. Electrode connection is on the rear. The recorder requires 10 watts of 115 volts AC power. It will operate reliably over the range of 100 to 130 volts.

OPERATION

Connect electrode to rear BNC connector. Set the temperature compensator knob to the solution temperature of the electrode. Plug in the power cord and turn on the power switch.

Either of the following two procedures may be used for calibrating the electrode. The voltage produced by different electrodes at a fixed pH such as 7.00 is slightly different. Consequently, the electrodes must be calibrated against buffer solution. One procedure is to dip the electrode tip into the buffer and adjust the calibration knob until the recorder reads the pH of the buffer. The other procedure is to calibrate a portable pH meter such as Model PA-10 or PA-11 with buffer. The pH of the solution being controlled is then measured with this meter and the calibration knob of the recorder is adjusted to make the recorder read the pH found with the portable meter.

BUFFER SOLUTION

Buffer solutions for calibrating the electrode are available from SERFILCO, 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 of buffer solutions available from SERFILCO is shown below.

Sample pH will also change with temperature depending on 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.

ELECTRODES

There are several types of electrodes available for SERFILCO recorders. A combination electrode is generally ordered with the instrument. A combination electrode has both a glass pH sensitive electrode and a reference electrode in one all glass unit. Separate glass and reference electrodes are for samples with problems such as high pressure or temperature.

The glass electrode produces an output voltage dependent on the pH of the solution on the outside of the electrode. The pH sensitive portion is a thin glass membrane with a spherical surface on the end of the electrode. Inside this bulb is a silver wire coated with silver chloride and buffer solution between the wire and the thin glass bulb. The amount of voltage produced depends not only on the pH but also on the temperature. Electrical contact with the solution is through the glass membrane, which constitutes a high resistance in the order of 25 to 100 megohms.

To complete the electrical circuit to the pH recorder, a second electrode is required. Both silver chloride and calomel reference electrodes are available. Each has certain advantages and disadvantages. Electrical contact from the reference electrode to the solution is through a fine junction, which will pass very little solution (see electrode specifications for filling solu-

Temperature	pH	pH	pH	pH
°C	1.68	4.01	7.00	9.18
	Tetroxalate	Phthalate	Phosphate	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	4.08	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	8.85

tion flow rate). The junction is either an asbestos fiber or ceramic rod welded into the glass. For combination electrodes, this junction appears just above the pH bulb and on the side. For separate reference electrodes, the junction is on the bottom. It is important that this junction be kept clean, otherwise the pH reading will drift. To clean, use a wet paper towel and wipe the junction several times.

REFERENCE ELECTRODE

All reference electrodes have two openings. During shipment, these openings are covered with a cap or rubber sleeve. Before the electrode is placed in service, both covers must be removed. A problem may be encountered in that the rubber tends to attach itself to the glass. Wet the glass and rubber with water. Work the water under the rubber by lifting the edge to allow water to run under. Once water is under the rubber, it will easily slide off.

An all glass reference electrode should be kept filled with filling solution at least one inch above the level of the solution being monitored. For accurate readings, the flow must always be out of the electrode and sample should not enter the electrode. This is more important with a silver chloride electrode than with a calomel electrode. Sample entering a silver chloride reference may cause a calibration drift of up to 0.3 pH whereas the electrode is calibrated with sample on the inside, it is possible to cancel out much of the error but it will return if conditions change.

SILVER CHLORIDE REFERENCE ELECTRODE

A silver/silver chloride electrode must be kept filled with 4M potassium chloride saturated with silver chloride. **Do Not** use filling solution without silver chloride or the electrode will be slowly damaged.

There are several reasons for selecting a silver chloride reference. Many types will operate at a high temperature. If through poor maintenance the filling solution is allowed to run out, there is generally less problem in establishing satisfactory operation when refilled than with calomel.

CALOMEL REFERENCE ELECTRODE

A calomel reference electrode must be kept filled with pure potassium chloride solution **Do Not** use filling solution containing silver or the electrode may be permanently damaged. There are several reasons for selecting a calomel reference. This is the most stable type of reference available. There is little effect of flow on the junction whereas a silver reference may change its output by as much as 0.2 pH from a no flow condition to a flow rate of a few feet per second past the junction. The presence of certain materials such as proteins or heavy metal ions may cause significant calibration drift of a silver chloride reference but they have no effect on a calomel reference. If a calomel reference is allowed to run dry, a bubble may enter the calomel cell and the electrode will cease to put out a stable signal. This bubble can only be removed by pulling a vacuum on the electrode and this is a laboratory procedure.

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, 10º and 40ºC the temperature correction is below 0.1 pH. Consequently, for this type of measurement, the temperature control may be left at 25ºC. 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 co-efficient 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 25ºC, each one pH change will produce an output change of 59 millivolts. At 50ºC, 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 one pH change on meter. The instrument temperature compensation knob is essentially a slope control or, in electronic terms, an amplified gain control.

ACCESSORIES

See Bulleting T-560 for Electrodes – specify BNC connectors.

MAINTENANCE

At weekly intervals, the filling solution level in the reference electrode should be checked. If a flow or immersion assembly is being used, the filling solution level need be checked only once a month. If the sample is oily or has a large amount of suspended solids, the glass pH bulb and the junction should be thoroughly wiped with a wet paper towel.

Periodically, the temperature of the solution being neutralized should be tested to determine if the temperature compensation knob is set correctly. The change in output voltage with change in pH is temperature dependent for all pH electrodes. The effect is known with high accuracy and can be accurately compensated. If the instrument is calibrated within one pH of the set point and the temperature does not change more than 20ºC, the error from temperature will be less than 0.1 pH. Consequently, for many applications careful monitoring of temperature is not necessary.

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