Interpreting pH Sensor Calibration Curves

This depends on the chemical composition and temperature of the samples that are measured regularly and can strongly affect how the efficacy of the sensor slope declines due to aging of the sensor's glass membrane. This information, therefore, provides clues that have to be interpreted taking into account the actual situation.

Situation	Cause	Try...
Virtually constant calibration results over all four logged calibrations	The sensor has hardly been subjected to the effects of aging.	Increase the calibration interval.
A constant reduction in slope or zero point drift	Normal aging process of sensor	Shorten the calibration interval to always measure with current data.
A constant, strong reduction in slope and/or zero point drift in one direction	Aging of the sensor can be accelerated by extremely acidic or basic samples and/or high temperatures.	Shorten the calibration intervals to always measure with current data. If the lifetime of the sensor is too short, make sure the sensor used is suitable for the samples to be measured and the measuring conditions.
An abrupt, sharp drop in slope compared to the last calibration	Impure electrolyte, dirty membrane, or defective sensor	Replace the electrolyte. Clean the membrane.[a] Replace the sensor.
Strong fluctuations among calibration results without any identifiable trend	Measurement conditions often vary greatly (e.g. very hot or very acidic or alkaline media to be measured).	Use special sensors for different measuring conditions.[a]
Strong fluctuations in the zero point without any identifiable trend	Fiber junction clogged	Clean the sensor.[a] Make sure the sensor used is suitable for the sample.
After a constant reduction in slope, an increase occurs.	Previous calibration was incorrect. Cleaning or regeneration improved the performance of the sensor.	Re-calibrate. Document cleaning and regeneration.

a. See the instructions that came with the sensor.

Temperature Compensation

Temperature has two major effects on pH readings: First, it affects the actual pH of a buffer or sample, and second, it affects the response of the of the electrode (sensor) itself. The meter automatically compensates for both effects when measuring pH.

Chemical pH Change Due To Temperature

Temperature changes cause chemical changes in the buffer or sample that result in small differences in pH readings. The pH of acidic buffers, for example, increases as their temperature increases; the pH of basic buffers drop as their temperature increases. To compensate, during calibration the meter reads the actual pH value of the buffer at its measured temperature. For instance, the meter will read a pH 10 buffer at 25°C as 10.00; the meter will read the same buffer at 20°C as 10.06.

The relationship between temperature and pH for each buffer or sample at a certain temperature can be described by the following equation:

$$pH = a + bT + cT2 + dT3.$$

The coefficients a,b,c, and d have been determined experimentally for different buffer solutions at temperatures ranging from 0°C to 100°C. This equation is used to determine the pH values shown in Table 1 on page 84. These coefficients are also stored in the pH meter and used to adjust pH measurements as temperatures changes.

The actual effects of the specific buffer's pH value vs. temperature are shown on each buffer solution label. Most technical buffers correspond to the values listed in Table 1 on page 84.

Table 1: Calculated Buffer pH Value at Specific Temperatures

Temperature	0°C	5°C	10°C	15°C	20°C	25°C	30°C
NIST (INTL) @ 25°C							
1.68	1.667	1.668	1.670	1.673	1.676	**1.680**	1.685
3.56	3.550	3.557	3.561	3.562	3.560	**3.557**	3.553
4.01	4.008	4.003	4.001	4.001	4.003	**4.007**	4.014
6.86	6.982	6.949	6.921	6.898	6.879	**6.863**	6.852
7.42	7.534	7.501	7.473	7.450	7.430	**7.415**	7.403
9.18	9.451	9.388	9.329	9.274	9.223	**9.176**	9.134
10.01	10.316	10.248	10.185	10.127	10.073	**10.024**	9.980
12.46	13.417	13.211	13.013	12.823	12.641	**12.467**	12.300
Sartorius / Reagecon Twin Neck Bottle @ 25°C							
4	4.004	4.000	3.999	4.000	4.003	**4.009**	4.016
7	7.142	7.102	7.069	7.042	7.020	**7.003**	6.991
10	10.341	10.261	10.187	10.119	10.057	**10.000**	9.947
Fisher (USA) @ 25°C							
2	1.985	1.991	1.995	1.998	2.000	**2.002**	2.004
4	4.004	4.000	3.999	4.000	4.003	**4.009**	4.016
7	7.142	7.102	7.069	7.042	7.020	**7.003**	6.991
10	10.341	10.261	10.187	10.119	10.057	**10.000**	9.947
12	12.593	12.458	12.317	12.173	12.027	**11.880**	11.733

Temperature	30°C	35°C	40°C	45°C	50°C	55°C	60°C
NIST (INTL) @ 25°C							
1.68	1.690	1.697	1.703	1.711	1.719	1.728	1.690
3.56	3.550	3.548	3.547	3.549	3.554	3.564	3.550
4.01	4.023	4.034	4.047	4.063	4.080	4.100	4.023
6.86	6.843	6.838	6.835	6.835	6.836	6.840	6.843
7.42	7.395	7.389	7.386	7.385	7.386	7.389	7.395
9.18	9.095	9.060	9.030	9.003	8.980	8.962	9.095
10.01	9.940	9.905	9.875	9.849	9.828	9.812	9.940
12.46	12.142	11.992	11.850	11.716	11.589	11.471	12.142

Temperature	30°C	35°C	40°C	45°C	50°C	55°C	60°C
Sartorius / Reagecon Twin Neck Bottle @ 25°C							
4	4.025	4.036	4.048	4.061	4.076	4.092	4.025
7	6.983	6.979	6.978	6.980	6.985	6.992	6.983
10	9.898	9.853	9.811	9.772	9.736	9.702	9.898
Fisher (USA) @ 25°C							
2	2.006	2.010	2.015	2.022	2.031	2.042	2.006
4	4.025	4.036	4.048	4.061	4.076	4.092	4.025
7	6.983	6.979	6.978	6.980	6.985	6.992	6.983
10	9.898	9.853	9.811	9.772	9.736	9.702	9.898
12	11.587	11.443	11.303	11.166	11.034	10.907	11.587

Temperature	65°C	70°C	75°C	80°C	85°C	90°C	95°C	100°C
NIST (INTL) @ 25°C								
1.68	1.678	1.679	1.680	1.681	1.682	1.682	1.683	1.684
3.56	3.562	3.521	3.463	3.386	3.283	3.151	2.984	2.775
4.01	3.934	3.929	3.923	3.917	3.912	3.906	3.900	3.895
6.86	6.470	6.412	6.346	6.271	6.184	6.084	5.968	5.833
7.42	7.022	6.963	6.897	6.821	6.734	6.633	6.516	6.379
9.18	8.606	8.541	8.476	8.411	8.346	8.281	8.216	8.151
10.01	9.406	9.336	9.266	9.196	9.126	9.056	8.986	8.916
12.46	10.687	10.477	10.267	10.057	9.847	9.637	9.427	9.217
Sartorius / Reagecon Twin Neck Bottle @ 25°C								
4	4.109	4.127	4.145	4.165	4.185	4.206	4.227	4.249
7	7.001	7.012	7.024	7.037	7.052	7.067	7.083	7.099
10	9.671	9.641	9.613	9.586	9.560	9.535	9.510	9.486
Fisher (USA) @ 25°C								
2	2.056	2.073	2.093	2.116	2.143	2.174	2.208	2.247
4	4.109	4.127	4.145	4.165	4.185	4.206	4.227	4.249
7	7.001	7.012	7.024	7.037	7.052	7.067	7.083	7.099
10	9.671	9.641	9.613	9.586	9.560	9.535	9.510	9.486
12	10.787	10.673	10.567	10.469	10.380	10.300	10.230	10.170

Sensor Response Change Due To Temperature

The response of the elctrode also changes as temperature changes, meaning that the the mV/pH slope changes at different temperatures. To compensate for this change, the meter adjusts the slope based on the temperature reading. At 25°C, the mV/pH slope is 59.17; at 20°C, however, the slope is 58.16.

The Isopotential Point

The mV reading where the sensor's mV/pH slope doesn't change as temperature changes is called the isopotential point.

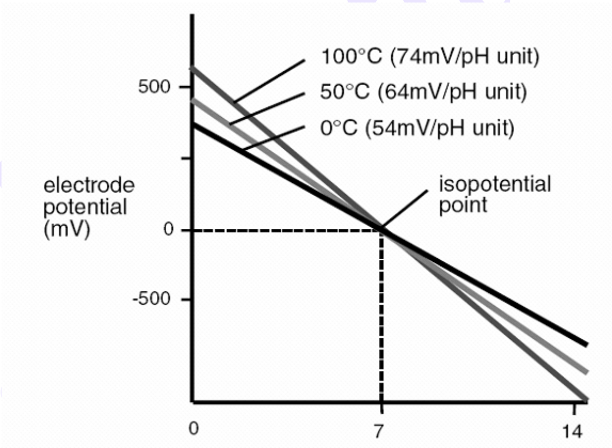

Fig. 22: pH sensor isopotential point

For highly accurate pH measurements where the sample temperature can widely vary, you can experimentally determine the isopotential point of the pH sensor and enter it into the meter.

Typical pH sensors have isopotential points near zero mV (which is the default setting for the meter).

Determining the Isopotential Point

For highly accurate pH measurements where the sample temperature can widely vary, the isopotential point of the pH sensor can be experimentally determined and entered into the meter.

1. Prepare a set of buffers or ion standards bracketing the linear range of the sensor.
2. Make sure the meter is in mV mode.
3. Place the buffers in a temperature bath at known temperature.
4. Measure and record mV readings of each pH or concentration.
5. Place the buufers in a bath at a second temperature.
6. Measure and record mV readings of each pH or concentration.
7. Repeat at several temperatures.

8. Plot the log of concentration or pH value versus mV reading.
9. Connect the points for each temperature. Where the lines intersect is the isopotential point:
10. See "Changing the Isopotential Point" next.

Changing the Isopotential Point

The isopotential point is the mV value at which the temperature of the measurement sample has no effect on the measurement. The default is 0 (zero) mV but you can set any value from −40.0 mV to 40.0 mV.

1. From the main menu, select Cal. Settings.
2. Select Iso. Point.
3. Enter the isopotential point you want to use. The default is 0000 mV.

RS-232 Serial Interface

The meter comes equipped with a data interface for connection to a computer or Sartorius printer.

Available Features

– Interface type: serial interface
– Operating mode: unidirectional
– RS-232
– Transmission rates: 300, 1200, 2400, 4800, 9600, 19200, 38400, or 57600 baud
– Parity: odd, even, none, mark, space
– Character format: 7-/8-bit ASCII, parity, 1 or 2 stopbits
– Handshake:
  2-wire interface: Software (XON/XOFF)
  4-wire interface: Hardware (CTS/DTR-none)
– Data output format: 24 characters

Female Interface Connector

9-pin D-subminiature DB9 connector with screw attachment for direct connection to a computer or a Sartorius data printer.

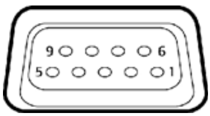

Fig. 23: Female 9-pin connector

Pin Assignment

Pin 1: Not connected

Pin 2: Serial data input (RxD)

Pin 3: Serial data output (TxD)

Pin 4: Data Terminal Ready (DTR)

Pin 5: Signal GND

Pin 6: Not connected

Pin 7: Not connected

Pin 8: CTS

Pin 9: Not connected

⚠ No other pins can be assigned in the meter!

Cabling Diagram

Diagram for interfacing a computer to the meter using the RS232C/V24 standard and cables up to 15 m (~50 ft.) long:

pH/mV meter, 9-pin		Computer, 9-pin
TxD	3	2
RxD	2	3
CTS	8	4
DTR	4	8
GND	5	5

Most Common Errors

- The baud rates between the meter and the computer/printer are different.
- The parity or stop bits are not set in the computer properly.
- The pins in the cable are not properly configured.

RS-232 Serial Interface Settings

You can change the configuration of the serial interface start bits, baud rate and parity setting. These must match the setting of the printer or computer being used with the meter.

Changing the Baud Rate

1. From the main menu, select `Meter Settings`.
2. Select `Interface`.
3. Select `Baud`.
4. Use the rotary dial to select one of the eight listed baud rates. The default is 1200.

Changing the Parity

1. From the main menu, select `Meter Settings`.