On-Line Electrode Impedance Measurement

MEASUREMENT

The Model 5081 pH/ORP Smart Transmitter, and the Models 1056 and 54e pH/ORP Analyzers include a diagnostic impedance measurement. This measurement is made between the glass pH electrode and reference electrode, and a solution ground or, in the case of the pH sensor without a solution ground, between the glass pH electrode and the reference electrode. In the latter case, the impedance of the reference electrode is small enough (a fraction of a megohm) to be negligible in comparison to the glass pH electrode, which can exhibit an impedance in the gigaohm range (10^9 ohms). The Model 5081 can measure glass pH electrode impedances from 0 to > 2 gigaohm with a specified accuracy of ±10% of reading or ± 2 megohm, whichever is larger. When using on-line measurements, the described effects in the charts that follow.

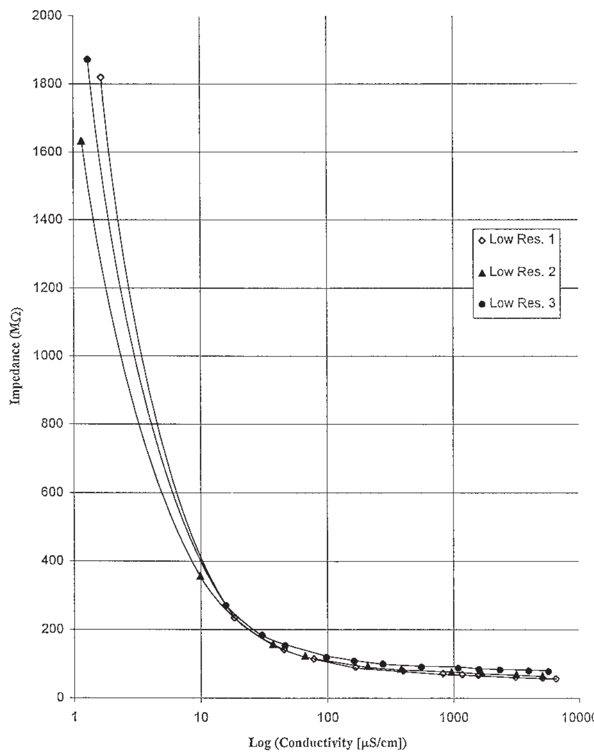

Chart 1. Glass Impedance vs. Log Conductivity

SOLUTION CONDUCTIVITY EFFECTS

The conductivity of the process solution can have an effect on the measured electrode impedance based upon the solution conductivity and the geometry of the particular pH sensor being used. The reason behind this effect is apparent when one considers that the impedance measuring circuit consists of not only the electrode(s) and/or solution ground, but also the resistance due to the process solution surrounding them.

The contribution of the process solution resistance to the overall measured impedance is inversely proportional to the solution conductivity. The electrode(s) and/or solution ground used for the impedance measurement form the electrodes of a conductivity cell, whose cell constant will depend upon the particular surface areas, distances of separation, and orientation of the electrodes.

For example, studies were done using the Model 381+ sensor in samples ranging from 1.0 to 10,000 µS/cm. The measured impedance was plotted against the inverse of the conductivity to yield a straight line with a slope equivalent to an apparent cell constant of 3,018 cm^{-1}. For all but the low resistivity electrodes, with impedance less than 100 megohms, the contribution of solution conductivity was negligible above 200 µS/cm. See Charts 1 & 2.

The distance between the glass pH electrode and the solution pH electrode and the solution ground in a Model 385+ is about 3/4 inch (1.9 cm). Decreasing this distance to 1/8 inch, by adding an extension to the solution ground, decreases the apparent cell constant and the conductivity effect by 90%.

In practice the effect of solution conductivity on a particular sensor can be checked by simply immersing it in a series of solutions with conductivity values spanning the expected conductivity range on-line. If the glass pH electrode and solution ground or reference electrode are within an inch of one another and the conductivity is 500 µS/cm or greater, any effect of conductivity should not be noticed.

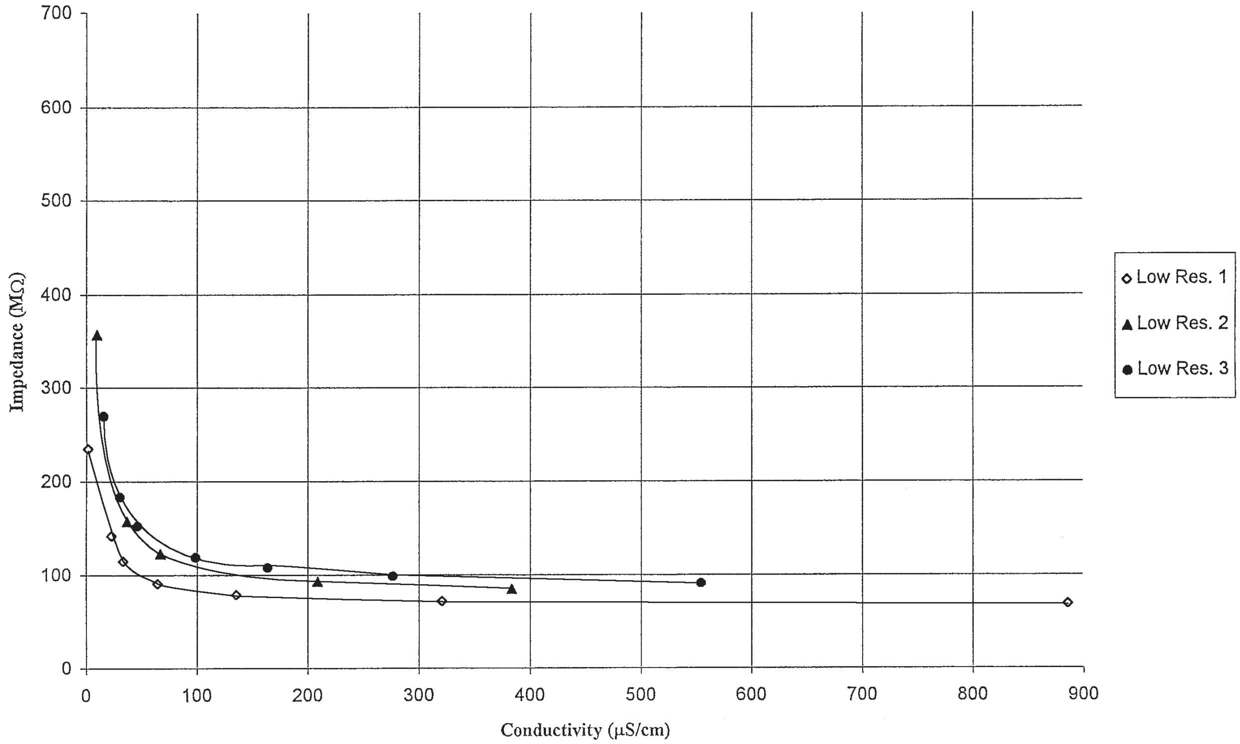

Chart 2. **Glass Impedance vs. Conductivity**

ON-LINE VERSUS LABORATORY IMPEDANCE MEASUREMENTS

When glass electrode impedance is measured by imposing a voltage, the glass electrode polarizes in proportion to the applied voltage. This polarization sets up an opposing voltage, which increases the apparent electrode resistance, and can represent a substantial fraction of the measured impedance. The full polarization effect can take up to one minute to develop.

The typical laboratory measurement of impedance often involves an applied voltage of 50 volts or more, which is applied until a stable impedance reading is reached. This implies that the pH electrode is fully polarized when the impedance reading is taken. In contrast, the Model 5081 pH/ORP and the Model 54e pH/ORP applies a lower voltage for a much shorter duration. **As a result, the Model 5081 pH/ORPand the Model 54e pH/ORP impedance reading, while repeatable, will indicate a lower value than the typical laboratory measurement.**

TEMPERATURE DEPENDENCE OF GLASS pH ELECTRODE IMPEDANCE

While the reference electrode impedance is independent of temperature, the glass pH electrode impedance is strongly temperature dependent, decreasing by roughly one-half for every 10°C increase in temperature. See Chart 3.

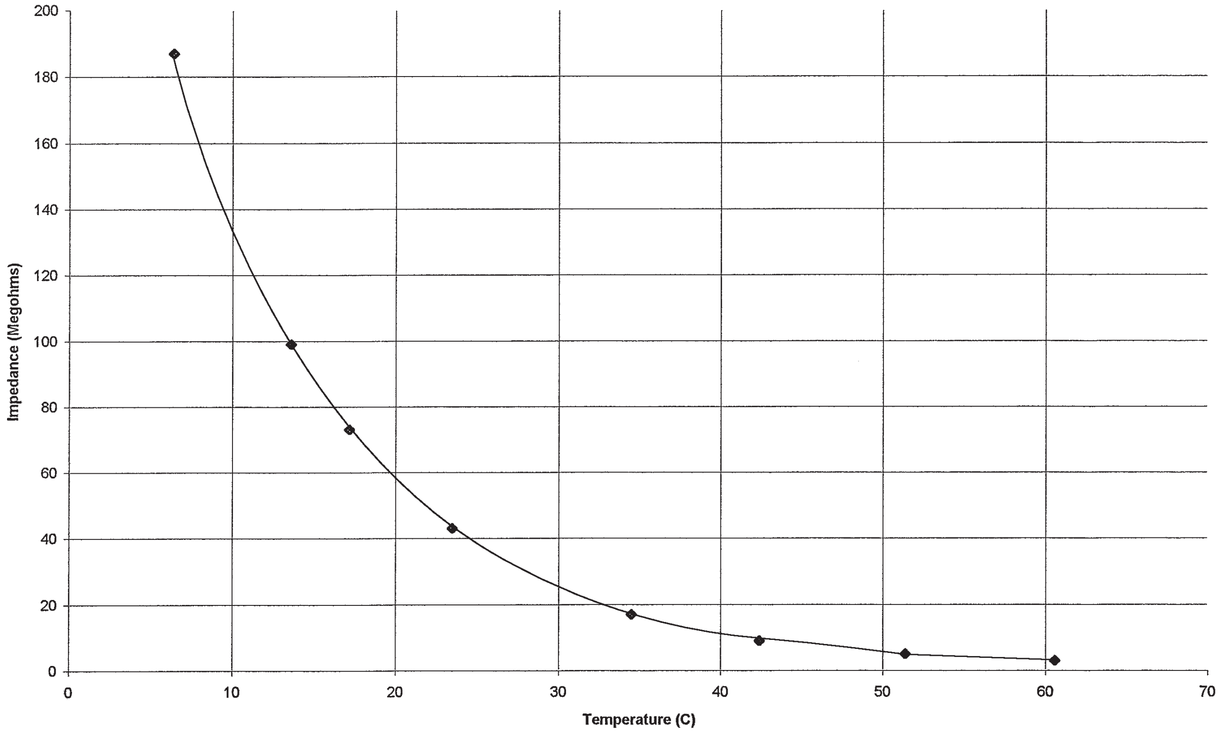

Chart 3. GPLR Glass Impedance vs. Temperature

INSTRUMENTATION

Model 54e pH/ORP Microprocessor Analyzer

- NEMA 4X (IP65) weather-proof, corrosion-resistant enclosure.
- Automatic temperature compensation.
- Dual isolated current outputs.
- Three process alarms with programmable logic, a timer function, and a fourth relay for fault conditions.
- Automatic buffer recognition with stored buffer temperature curves.
- Advanced on-line sensor diagnostics.

Model 1056 Analyzer

- MULTI-PARAMETER INSTRUMENT – single or dual input. Any combination of pH/ORP/ISE, Resistivity/Conductivity, Chlorine, Oxygen, Ozone, Turbidity, Flow.
- LARGE DISPLAY – easy-to-read process measurements.
- SEVEN LANGUAGES: English, French, German, Italian, Spanish, Portuguese, and Chinese.
- HART AND PROFIBUS DP Digital Communications.

Model 5081 pH/ORP Microprocessor Transmitters

- Hand-held infrared remote control link activates all the transmitters functions.
- Large custom LCD display.
- NEMA 4X (IP65) weatherproof, corrosion-resistant enclosure.
- Comprehensive pH glass and reference diagnostics.
- Non-volatile EEPROM memory to hold data in event of power failure.
- HART® or FOUNDATION Fieldbus options.

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