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The Value of the pH Simulator in Fault Diagnosis

1 Introduction

When investigating problems with a pH system, it is frequently necessary to check the integrity of the transmitter itself, the electrode cable, and terminations. The company has produced a suitable simulator since the 1950s, although there has been many different models up to the present day, it is evident that few people are aware of the true purpose of this device and its vital role in identifying the cause of the various problems that frequently occur.

2 2410 pH Electrode Simulator

High electronic accuracy is not required with most pH instruments because normal routine electrode calibration would remove small electronic errors. During a normal electrode calibration, the gain is adjusted by up to ±50% and the zero offset up to ±180mV, any large electronic errors will only effect the calculation of the slope value and the check reading. Therefore, a frequent check on the electronic calibration using a simulator is totally unnecessary. The current Model 2410 simulator is accurate enough to carry out an electronic calibration, but this should not be considered as its primary role.

It can not be stressed strongly enough that a pH Simulator should **NOT BE CONSIDERED AS JUST AN ELECTRONIC CALIBRATOR**. It is a very common misconception that these simulators are used only as a means of checking the electronic calibration of the transmitter. High stability resistors are used in the input board circuitry and once calibrated, the A to D converter chip is self-compensating for zero and span drift.

A pH simulator is a device, which is basically a battery operated mV source that has a range of ±1000mV. What makes this device different is the additional ability to simulate the impedance of the glass electrode. The current Model 2410 pH Simulator has an accuracy of ±0.02pH and ±0.1% in mV. The mV output of the simulator can be adjusted to correspond to pH value equivalent for temperatures between 0 and 100°C.

3 Fault Diagnosis

The majority of all problems associated with industrial pH installations are caused by one or other of the pH electrode pair, these should be checked, i.e. cleaned or replaced. However, if the problem remains unresolved then it is necessary to look at the transmitter itself, the electrode and cable terminations, damaged cable.

A check can be made to confirm that the transmitter responds to an input by injecting various mV values from the simulator (see the simulator and transmitter instruction manuals for details). The input mV value can be displayed, so the instrument can be treated as a digital voltmeter. Simulating pH values and carrying out a sensor calibration is time consuming, potentially unreliable, and unnecessary. It should always be remembered that this type of test is not carried out during the manufacturing tests, or factory repairs.

So far the simulator has only been used as a simple mV source, although convenient, any mV generator could be used to carry out these tests. The simulator can now be used to simulate the very high impedance of the glass electrode by providing a means to test that the necessary input insulation in the electrode cable and input impedance is being achieved.

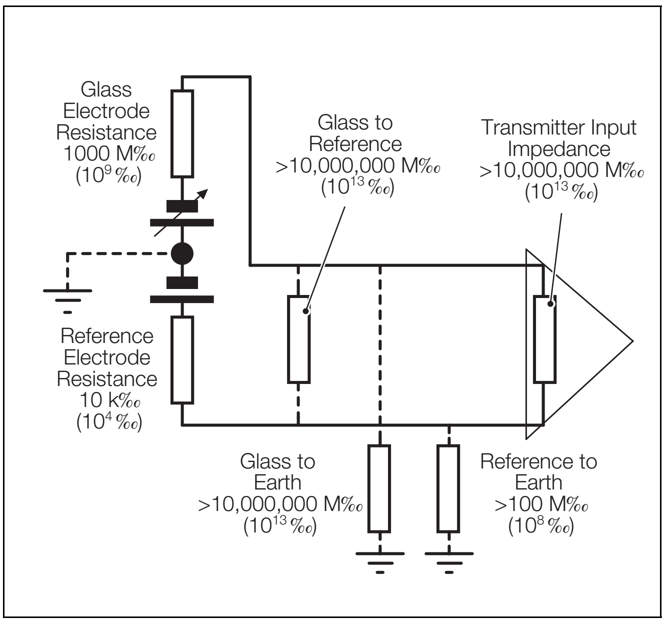

Fig. 3.1 Equivalent Electrical Circuit for a Standard pH Electrode System

The glass electrode can have an impedance of up to 1000MΩ (109Ω) and the reference electrode up to 10kΩ (104Ω). With this high source impedance, good insulation is essential in all electrode terminations, both between one another and between each one and earth (ground). High insulation to earth is required because most on-line pH measurements are carried out in an earthed solution. The order of impedance required on the transmitter input and electrode terminations are shown in the diagram above:

After electrode problems, the next most common fault with pH systems is low insulation, possibly due to moisture around the electrode cable terminations. This high level of insulation cannot be measured directly and is often beyond most people's appreciation. Very little moisture, often invisible, can cause significant problems, often freezing the reading at 7pH, sending the reading off scale, or causing the readings to drift. Dirty or greasy hands when touching electrode terminations are often enough to reduce the insulation to an unacceptable level. Even silicon grease, water dispersant, e.g. WD40, or sealants around the terminations is very bad, because it can reduce the insulation so much, that the electrode terminal block or connector will have to be thrown away. This also includes electrode, with detachable cable.

The simulator is used to check for a low impedance input to the transmitter by adjusting the simulator to 14pH and than switching to 1000MΩ on the function switch and observing that the reading on the display does not change by more than 0.02pH. This test introduces a 1000MΩ resistor (equivalent to the glass electrode impedance) in series with the output of the simulator. In a similar way, low impedance path between the glass lead and earth, can be detected by connecting the simulator earth terminal to a good known earth. Leakage to earth should be checked with the aid of a digital multimeter. The electrode cable and terminations can be checked by connecting the simulator to the each end of the electrode cable and repeating the insulation test.

A pH simulator can also be used to check the electronics and sensor terminations on ion-selective monitors in exactly the same way, although the monitor manual will need to be consulted for connection details. In this case, a change of one pH unit in output from the simulator, i.e. 60.15mV at 25°C, is the equivalent of one decade change in concentration of the ion being measured.

The simulator, as mV source and a device for checking the high impedance, is therefore, a vital tool in identifying these insulation problems. In many circumstances, identifying the cause of the problem cannot be traced by any other method.

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