pH METER 350/370 3510/3520 Application note: A01-001A

The Change in pH Electrode Response Times with Varying Water Sample Temperatures

Introduction

The measurement of pH in pure water has met with variable success. The high resistivity of pure water, vulnerability of the sample to contamination, variability of reference electrodes and additional temperature effects converge to make this a particularly challenging measurement.

This application note will investigate the response times, to reach a constant pH, of two Jenway pH electrodes. Firstly a Jenway combination pH electrode (924 005) and secondly a Jenway environmental pH electrode (924 050) The Jenway environmental electrode has been specifically designed for use with solutions of low ionic strength.

One of the first difficulties in making any pure water measurement is preserving the integrity of the sample. A constant threat of contamination comes from carbon dioxide in the air. Pure water will absorb enough CO_2 to yield a pH of approximately 5.2. Therefore in this application note the pure water will be allowed to equilibrate with the atmosphere prior to analysis so that pH value is not affected by the absorption of CO_2.

This application note will compare the response times of these two electrodes, when measuring the pH of pure water at a variety of commonly encountered temperatures. The optional DATAWAY software will be used to record the results.

Methods

Effect of Temperature on Electrode Response times

Purified water was obtained from an Elga purified water system. The water was then allowed to equilibrate with the atmosphere for 30 minutes. Four 50ml aliquots were withdrawn and placed in separate 100ml Pyrex beakers. In turn, these four aliquots were adjusted to 4.0℃ (±0.5℃) using an iced water bath. A PTFE stirrer bar was placed in each sample and this was used to stir the sample at the stirrers' lowest working setting of approximately 100rpm. The combination and environmental pH electrodes: were then used to measure the pH values of the samples at 5 second intervals. Jenway's DATAWAY software was used to record the data until readings changed by less than 0.05 pH units over a period of 30 seconds. Single samples of air saturated water were then measured at 10.0℃, 15.0℃, 20.0℃, and 25.0℃ (all ±0.5℃) to determine the response times of each electrode.

Results

The results collected for the combination and environmental electrodes at 4℃ are shown in Figures 1 and 2..

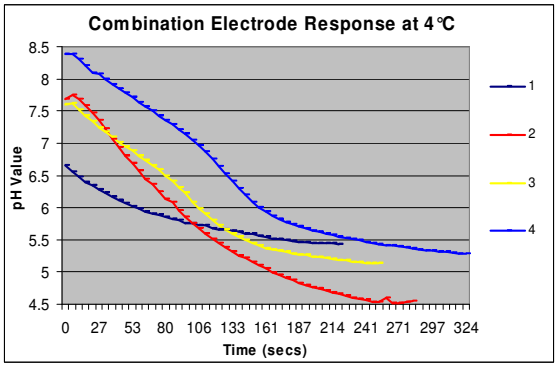

Figure 1: The response of the combination electrode at 4℃.

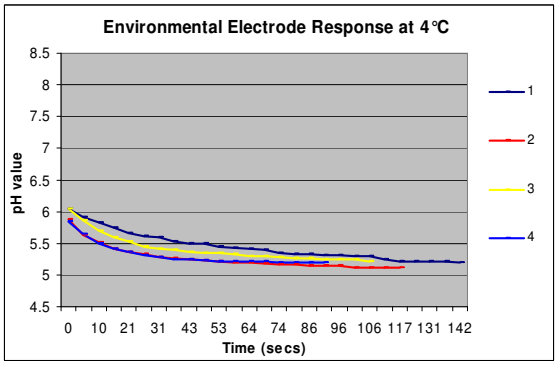

Figure 2: The response of the environmental electrode at 4℃.

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The environmental electrode gave stable readings in less than half the time of the combination electrode at 4°C, on average 156 seconds faster. The electrode response times at 4°C are shown in Table 1. The environmental electrode gave more consistent results, with a standard deviation of only 22 seconds

Repetition	Electrode Response Time at 4°C (seconds)	
	Combination	Environmental
1st	229	148
2nd	288	126
3rd	262	112
4th	330	96
Mean	277	121
Std.Dev.	42.66	22.05

Table 1: The response times of the combination and environmental electrodes at 4°C.

At all temperatures tested below 20°C the environmental electrode gave stable results much faster than the combination electrode. The efficiency of the electrode was more pronounced at the lower temperatures. The response times of both electrodes at 4, 10, 15, 20, and 25°C, are shown in Table 2.

Temp °C	Electrode Response Time (seconds)	
	Combination	Environmental
4	Mean = 277	Mean = 121
10	190	81
15	146	66
20	47	42
25	46	42

Table 2: The response times of the combination and environmental electrodes at 4, 10, 15, 20, and 25°C.

Figure 3 shows the change in electrode response times versus the change in sample temperature. This clearly shows the faster response time of the environmental electrode.

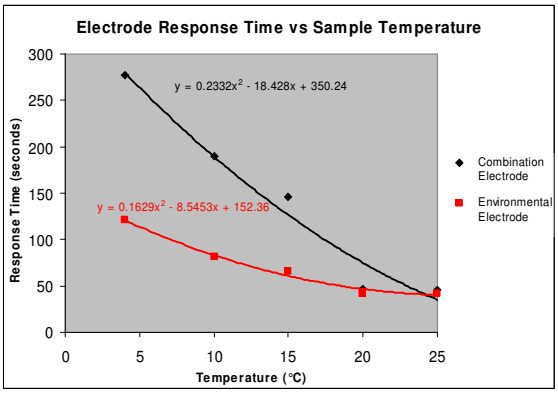

Figure 3: The change in the combination and environmental electrodes response times with varying sample temperature.

Conclusions

The Jenway environmental pH electrode shows much faster response times in the testing of low ionic strength solutions when the samples temperatures is below 20°C. The benefits of the environmental electrode become even more apparent when used at very low temperatures. The Jenway combination pH electrodes response time is approximately 2.5 times slower that of the environmental pH electrode when measuring pure water at 4°C.

The environmental pH electrode is therefore considered of particular benefit to analysts working in the field who need to repeatedly measure the pH of ground and surface water samples. The reduced analysis time or increased sample throughput will soon justify the small additional investment required to purchase the environmental electrode.