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Tech Note

Linearity and Accuracy of Conductivity Sensors on YSI 6-Series Sondes

The conductivity sensors on YSI 6-Series sondes have excellent specifications with regard to stability and accuracy. The conductivity systems (circuit and probe) used with these instruments show typical accuracy of ± 0.5 % of the reading over a wide range (0-100 mS/cm), making it unnecessary for users to employ one probe for freshwater and a different probe for marine applications. Naturally, this accuracy specification requires proper user calibration with standards of high accuracy.

Like most conductivity systems, the circuitry employs a variety of ranges, but because of the YSI 'autoranging' protocol, this feature is transparent to the user. Many manufacturers of conductivity meters and sensors provide an accuracy specification as a percent of range, while YSIís accuracy is quoted as percent of reading. The latter specification guarantees better accuracy at all conductivity values as evidenced by the following example:

A freshwater sample shows a conductivity of 800 uS/cm that is read on a range of 0-5000 uS/cm on two instruments, one which quotes accuracy as percent of reading and the other quoting accuracy as percent of range. Clearly the error for the former instrument is 0.005 x 800 = 4 uS/cm. However, the accuracy for the latter instrument is the same anywhere in the 0-5000 uS/cm range and is 0.005 x 5000 = 25 uS/cm. Thus, for the percent of reading instrument the measured value is 800 ± 4 uS/cm (0.5 %) while for the percent of range instrument the measured value is 800 ± 25 uS/cm (3.1 %). Note that, at the top of any range, the percent of range and percent of reading accuracy specifications are identical. However, for values less than the top of each range, the actual accuracy is always better for an instrument specified in the percent of reading protocol.

Time min	Temp °C	Specific Conductance, mS/cm Actual	Measured	% Error
0	25.1	10.00 ±0.25%	10.00	0.0
1	25.1	10.00 ±0.25%	10.00	0.0
2	25.1	10.00 ±0.25%	10.00	0.0
3	25.1	10.00 ±0.25%	10.00	0.0
4	24.8	1.00 ±0.5%	1.000	0.0
5	24.9	1.00 ±0.5%	1.000	0.0
6	24.9	1.00 ±0.5%	1.000	0.0
7	24.9	1.00 ±0.5%	1.000	0.0
8	24.9	1.00 ±0.5%	1.000	0.0
9	24.9	10.00 ±0.25%	49.79	0.42
10	24.9	50.00 ±0.25%	49.79	0.42
11	24.9	50.00 ±0.25%	49.80	0.50
12	25.0	50.00 ±0.25%	49.81	0.38
13	24.9	50.00 ±0.25%	49.82	0.36
14	24.9	50.00 ±0.25%	49.81	0.38
15	24.9	50.00 ±0.25%	49.82	0.36
16	24.9	50.00 ±0.25%	49.82	0.36
17	24.9	50.00 ±0.25%	49.82	0.36

Table 1. Measured Conductance versus Actual Conductance.

The same conductivity system is used on all EMS instruments (600R, 600XL, 600XLM, 600OMS, 6820, 6920, 6600 and 6600EDS). The following actual data were recorded using a Model 600R, but the results will be typical of all sondes. In the experiment, the sonde was placed in 10 mS/cm conductivity standard certified by YSI's Metrology unit to be accurate to ± 0.25 %. The instrument was calibrated according to the instructions outlined in the manual and then several instrument readings recorded at a 1 minute sample interval to demonstrate the system stability. The sensor was carefully rinsed with deionized water and then dried. The sonde was then placed in 1.0 mS/cm standard certified to be accurate to ± 0.5 % and the instrument readings recorded, with the actual value and stability noted. The rinse-dry cycle was repeated and then the sonde was placed in 50 mS/cm standard certified to be accurate to ± 0.25 % and the readings again recorded. The data are shown in Table 1.

As can be seen from the data, all readings are within the quoted typical accuracy specification of the conductivity system (± 0.5 % of reading) after calibration of the system at 10 mS/cm, and also show excellent stability.

It must be remembered that a great deal of care was taken in this experiment:
1 - The sensor was carefully rinsed and dried prior to changing standards;
2 - High quality standards were used;
3 -The readings were taken under controlled temperature conditions close to 25˚C (where the standard accuracy is specified) to minimize any temperature compensation errors;
4 - The sensor was new with perfectly clean electrodes.

A compromise of any of these factors could have resulted in readings that were apparently outside of the accuracy specification. Note: YSI quotes typical accuracy specifications for all sensors that we believe characterize most of our instruments.

The data shown above, as well as additional conductivity data that supports the accuracy specification, are from internal YSI studies.

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