# A CALIBRATION METHOD FOR THE CONDUCTIVITY MEASUREMENT AT TEMPERATURES FROM 10 ºC TO 20 ºC

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*Abstract- The objective of this paper is to define one method for the characterization of the measurement system of conductivity on liquids at temperatures different from 25 Celsius degree. This characterization has the objective to know the average values and the uncertainty of the measured conductivity.*

*Keywords- conductivity, temperature, uncertainty, CTD calibration*

## INTRODUCTION

With the commercial conductivity meters available, nowadays it is possible to obtain measurements with its uncertainness associated at 25ºC only because this is the temperature for what the conductivity standard solutions can be found with certified traceability.

In our application, the measurement equipments are located in the seafloor of the western Mediterranean coast, for what they will work in a temperature range from 10 to 20ºC. Knowing the uncertainty of the measurement device in the temperature operation interval will contribute to a better reliability of the obtained data. Once measured the conductivity value, it is possible to calculate also the salinity and obtain its average value with an associated uncertainty.

## PROCESS

For this calibration method, first of all a conductivity cell is required. In order to evaluate the method a custom made cell developed in our lab has been used. Once the cell has been manufactured, its associated uncertainty has been calculated using an appropriate method:

A. Sensor and measurement system
B. Prototype tests, linearity and interference
C. Uncertainty calculation of the cell factor K for our device
D. Conductivity calculation and its uncertainty for a liquid solution

## DEVELOPMENT

A. Sensor and measurement system

The prototype, Fig.1., is composed by a couple of cooper boards inside a plastic package. This package ensures the position stability between boards. The boards size is 10 mm x 20 mm, and its separation is 4 mm.

B. Prototype tests, linearity and interference

The linearity of the system must be tested before the cell factor calculation. The objective of this test is to verify the linearity of the output current against different values of conductivity [1]. For this test we use a commercial conductivity meter, the GMH3430, and liquid samples of several conductivities that have been prepared by mixing natural water and sodium chloride (NaCl).

A Second test has been done to measure the interference between the GMH3430 and our system. A maximum interference value of 0.5% cannot be exceeded.

C. Uncertainty calculation of the cell factor K for our device

This is the main point of this paper, because it is the calculation procedure for the cell factor of our system and its associated uncertainty. The used equipment for this test is:

- Climatic chamber
- Standard thermometer
- Standard solution with traceability at 25 Celsius degree
- Prototype of developed conductivity cell

When the standard solution and measurement sensors are stabilized at 25ºC, a reading of the output current of the system is measured. In this example, 109 samples have been taken. The cell factor can be calculated with the equation (1) [2].

$$K = \frac{\gamma}{G\cdot(1-\alpha\Delta T)} \quad (1)$$

Due to the fact that it is not possible to stabilize the temperature exactly at 25 ºC within the climatic chamber, the correction temperature factor in (1) has been included. In the other hand, there is no need for pressure correction because the test has been done at atmospheric pressure.

Once obtained the value of K, its associated uncertainty is calculated with different contributions. The main contributions are:

- Measurements repeatability
- Error propagation (2)
- Step variation between top and bottom values
- Standard solution uncertainty

$$\delta K = \sqrt{\left(\frac{1}{G\cdot(1-\alpha\Delta T)}\cdot\delta\gamma\right)^2 + \left(\frac{\gamma}{(1-\alpha\Delta T)\cdot G^2}\cdot\delta G\right)^2 + \left(\frac{\gamma\cdot\Delta T}{G\cdot(1-\alpha\Delta T)^2}\cdot\delta\alpha\right)^2 + \left(\frac{\gamma\cdot\alpha}{G\cdot(1-\alpha\Delta T)^2}\cdot\delta\Delta T\right)^2} \quad (2)$$

The cell factor value obtained with this procedure is K = (0,69 ± 0,06) cm-1.

D. Conductivity calculation and its uncertainty for a liquid solution

To calculate the conductivity of a sample and the uncertainty associated at temperatures different to 25 ° C, equation (3) can be used. It is expresses the conductivity as a function of temperature [2].

$$\gamma = G\cdot k\cdot\left(1-\alpha\cdot(T-T_0)\right) \quad (3)$$

We use the standard solution because the manufacturer gives the average value of conductivity at different temperatures. Using the climatic chamber the standard solution is brought to 15 Celsius degree and then a reading of the output current of the system is taken. The uncertainty budget is detail at (4).

$$\delta\gamma = \sqrt{(G\cdot(1-\alpha\cdot\Delta T)\cdot\delta K)^2 + (K\cdot(1-\alpha\cdot\Delta T)\cdot\delta G)^2 + (K\cdot G\cdot\Delta T\cdot\delta\alpha)^2 + (K\cdot G\cdot\alpha\cdot\delta\Delta T)^2} \quad (4)$$

## CONCLUSION

In this paper we implemented and detailed the calibration method for measurement conductivity systems. We got an average value and associated uncertainty for conductivity measurements of liquid solutions at 15 Celsius degree.

***REFERENCES***

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***Figure 1. Prototype***