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Abstract – The measurement of electrolytic conductivity is widely applied as a control parameter and its relevance is continuously increasing, not only in industrial applications but also in the environmental monitoring domain. In this work the attention is focused on the electrical behaviour of a low cost in-situ four electrode conductivity sensor for water quality monitoring in estuaries and oceans.

The design of the sensor, the method used to determine the conductivity value, the circuit developed for signal conditioning and the data acquisition board that links the sensor to the computer for further signal processing are described in detail. The output values of the conditioning circuit are stored in the computer and compared with more accurate conductivity values obtained from commercial equipment. In order to obtain mare accurate results algorithms for digital signal processing have been presented and implemented.

Keywords - conductivity cell, electrolytic conductance, salinity.

I. INTRODUCTION

The measurement of electrolytic conductivity is widely applied in several application domains and the increase of its relevance has boosted research in the area. In order to obtain absolute methods, this measurement has recently undergone a critical revision [1], systems for traceable measurements are being developed [2] and the research for the best conductivity cell is always a goal for scientists and experimentalists [3-6]. In this paper the attention is focused on the electrical behaviour of a low-cost in-situ four electrode conductivity sensor for water quality monitoring in estuaries and oceans.

Although water itself is a poor conductor of electricity, the presence of ionic species in solution increases the conductance considerably. The conductance of such electrolytic solutions depends on the concentration and nature of the ions present. Conductivity is calculated from conductance, defined as the reciprocal of the resistance, measured by a sensor.

Electrode Conductivity Sensor

This paper presents a conductivity sensor that includes the implemented cell presented in Fig. 1 with four electrodes and a plastic tube [7-9].

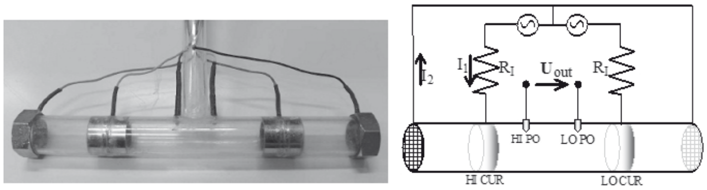

Fig. 1. Photo of the implemented four electrode cell.

Two electrodes are ring shaped and stand inside the tube and the other two are metallic tips to measure the output voltage. The tube is closed on the two ends with metallic grids to achieve field confinement in the cell. The cell is connected to a printed circuit board with all signal conditioning circuitry whose output is connected to a data acquisition board to digitize data to be processed by the computer.

The geometry of the cell assures that the current inside the cell (in the region between the electrodes) equals the current that flows from the current sensors to the metallic grids on the top ends of the cell. That leads to a constant cell, Kc = 50 m-1.

II. EXPERIMENTAL CHARACTERIZATION

Tests take place in an automated temperature controlled bath using tap water as the solution whose conductivity is to be determined [10]. Sodium chlorite is used to increase water's conductivity in order to study sensor's output changes. The calibration of the conductivity value of the solution is performed with a commercial sensor from Hanna Instruments, HI 255-01.

At a first stage measurements are taken to adjust multiturn trimmers included in the conditioning system to their optimal value which is the one that leads to a minimal error for the desired range of conductivities to be measured. Fig. 2. presents the results obtained for $P_1 = 0.25\Omega$ and $P_2 = 4.65\Omega$ being 20% the worst relative error.

An algorithm to determine the value of the liquid conductivity from the output sensor voltage is implemented. Fig. 3 presents the liquid conductivity estimated.

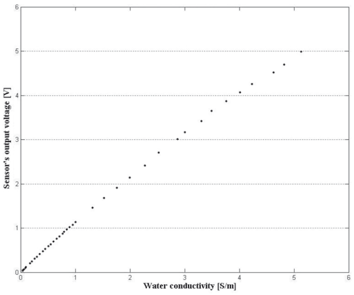

Fig2. Sensor output voltage for different conductivity values.

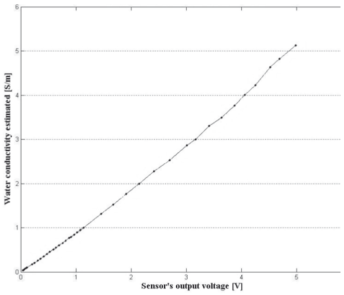

Fig3. Liquid conductivity estimated as a function of the sensor's output voltage

III. CONCLUSIONS

One advantage of the implemented cell derives from its full internal field. Because the field is internal, small amounts of antifouling material placed at the ends of the cell are effective in preventing internal fouling. Even if there are some limitations associated with the present solution, as the KC variation and a relatively poor flushing, the main advantages of this solution are its low cost, small proximity effects dependence, small amounts of antifouling material required and low volume of baths for calibration purposes.

Digital signal processing techniques and auto-calibration techniques can be used to improve measurements accuracy.

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