Inductive Conductivity Measurement of Seawater

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Introduction: This paper presents a methodology that can be employed to accurately determine the conductivity of seawater. This measurement technique accurately facilitates the estimation of the dissolved mineral content and also the phase transition point of the measured volume of seawater.

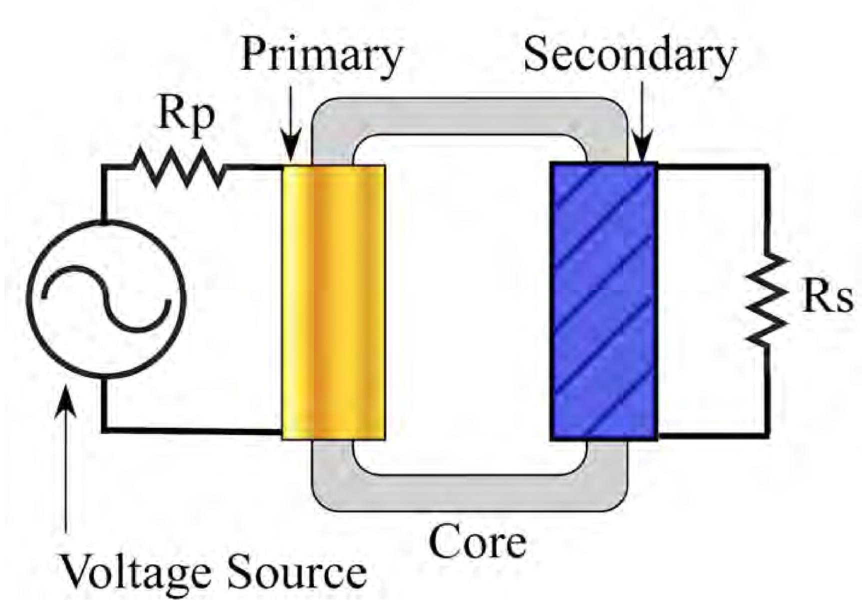

Figure 1. O-Core Transformer Cells, Core and Circuit Configuration

Computational Methods: COMSOL Multiphysics is employed to build a parametrically swept model of an o-core inductive conductivity measurement sensor for seawater. This sensor model is built using the COMSOL Multiphysics Magnetic Fields (mf) and Electric Circuit (cir) physics interfaces.

In a magnetic transformer circuit with a primary coil, a secondary coil, a mean core length, and a cross-section area, Ampere's Law states that the line integral of the magnetic field intensity around a closed contour is equal to the total current enclosed. In the case where there are a discrete number of loops, as in the case of a closed transformer core multi-turn coil, this equation becomes:

$$\sum_{N} H \cdot l = Ni$$

The voltage applied to the primary coil induces a magnetic flux in the ferromagnetic o-core.

The flux in the o-core, in turn, induces a voltage in the secondary coil. As the conductivity of the seawater changes, the voltage developed across the load resistor changes accordingly.

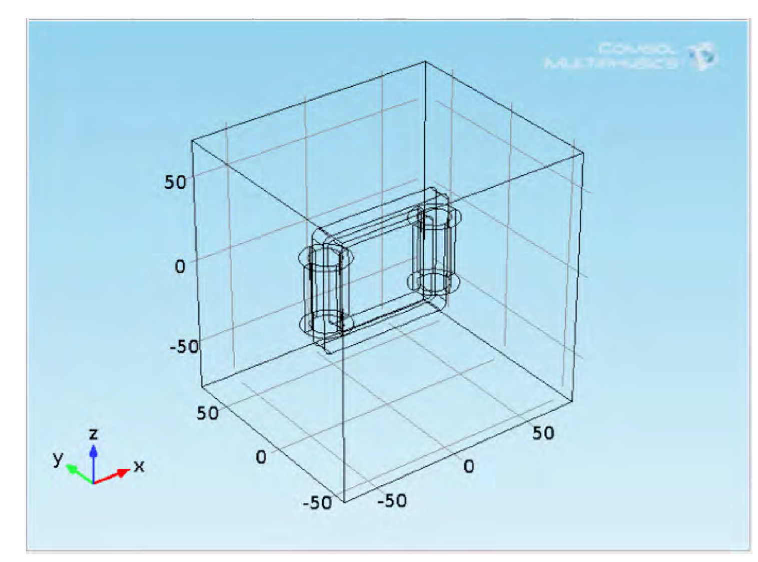

Figure 2. O-Core Inductive Conductivity Sensor

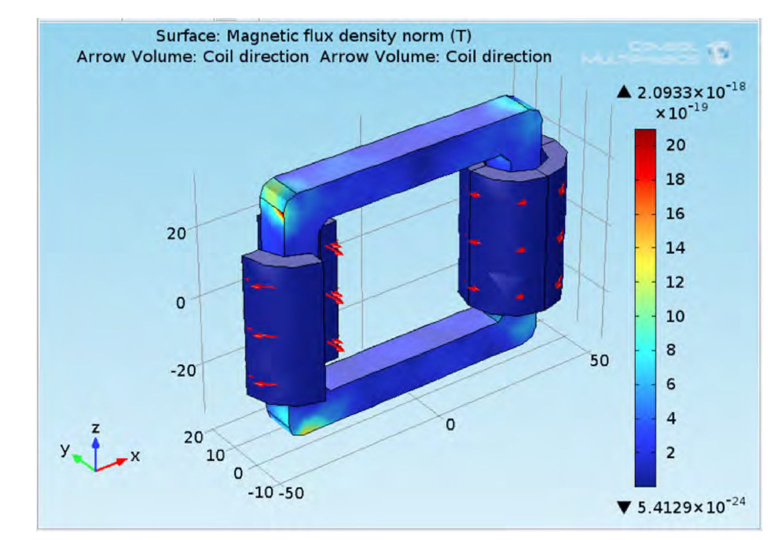

Figure 3. O-Core Magnetic flux density and coil currents.

Results: The plot shows changes in the conductivity of seawater are easily detectable using this method.

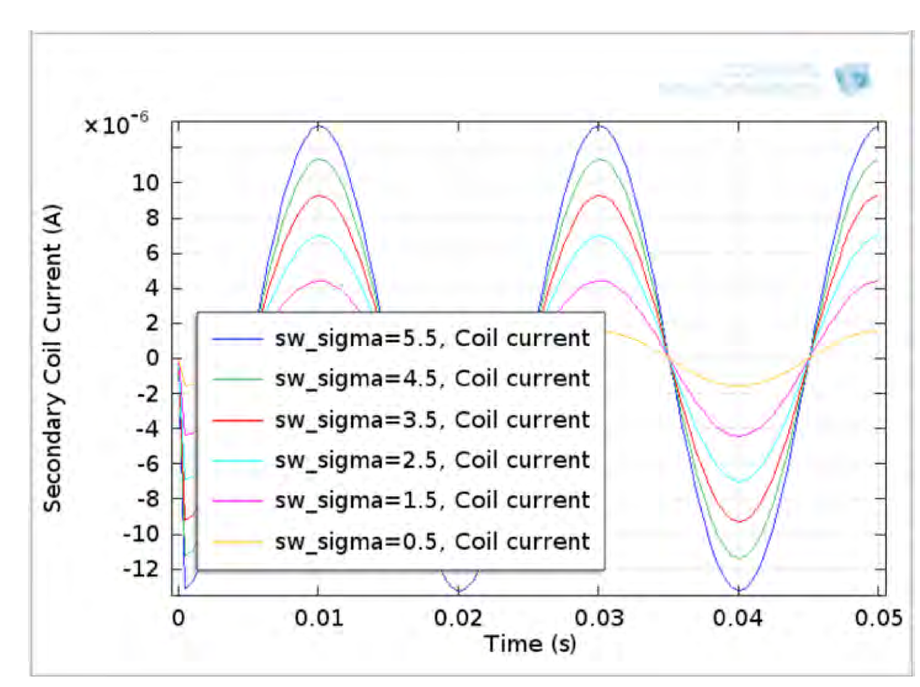

Figure 4. Secondary Voltage vs. Conductivity

Conclusions: This model demonstrates that changes in seawater conductivity are readily measured with an inductive methodology. For a detailed overview of the many applications that utilize the conductivity of seawater and other liquids, I refer the reader to the literature.

References:

1. Pryor, Roger W., Inductive Conductivity Measurement of Seawater, Proceedings of the 2013 COMSOL Conference (Boston) (2013)