Inductive Conductivity Measurement of Seawater

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4. All of these mechanisms are ultimately controlled by the properties and heat content of the vast volumes of seawater that underlie the atmosphere.

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The conductivity of the resulting solution (seawater) directly correlates with the concentration of dissolved salts.

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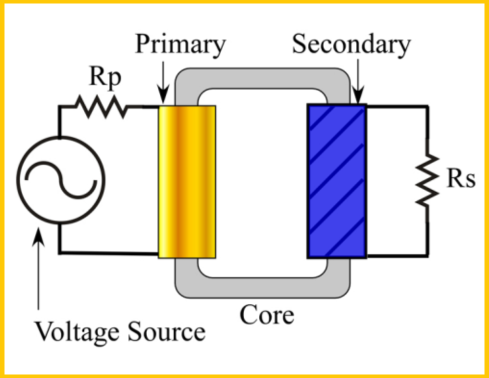

Figure 1. O-Core Transformer Coils, Core and Circuit Configuration.

Transformer Theory

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$$Vac = -N_P \frac{df}{dt}$$

Transformer Theory

Figure 2 shows 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 {6}.

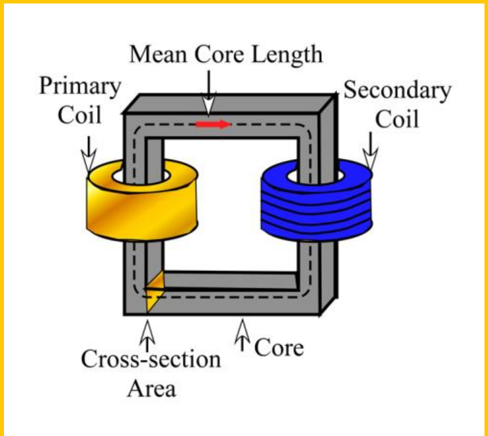

Figure 2. Magnetic Transformer Circuit Showing the Primary Coil, the Secondary Coil, the Mean Core Length, and Cross-section Area.

Inductance Theory

Assuming that the transformer of Figure 2 has an applied load, then 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 {7}:

$$V_S = - N_S \frac{df}{dt}$$

Inductance Theory

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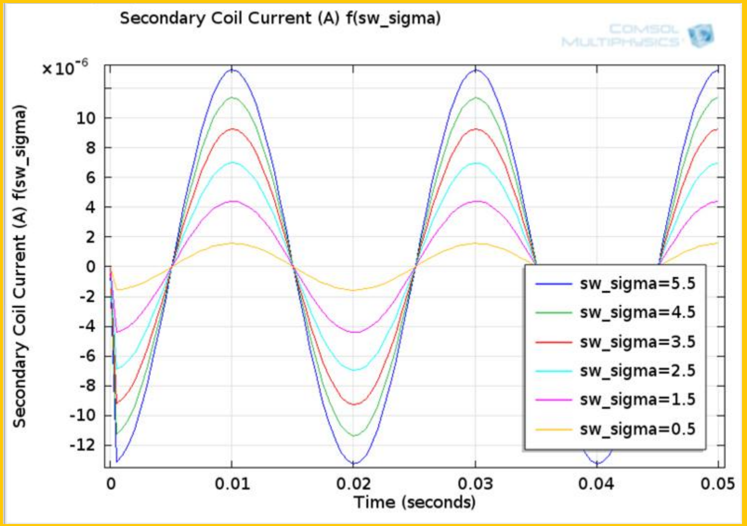

Figure 3. Secondary Coil Output Voltage as a Function of Seawater Conductivity Change.

Use of COMSOL Multiphysics

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COMSOL Multiphysics is employed herein 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.

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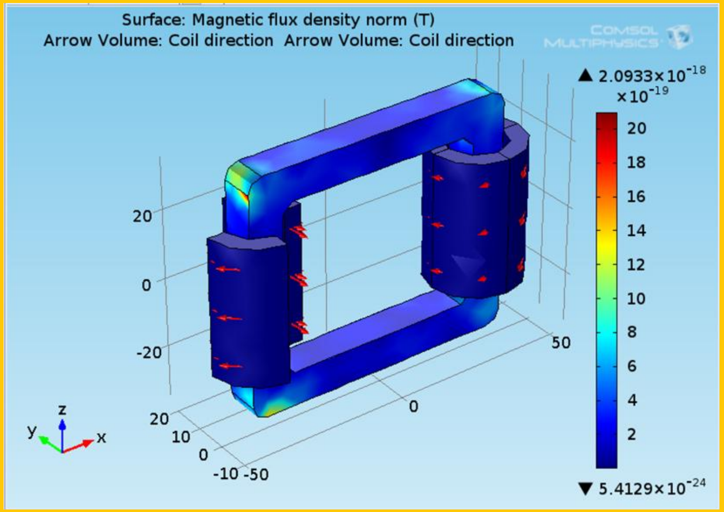

Figure 4. Magnetic flux density in the O-core and the currents in each multi-turn coil.

Results

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Figure 5 shows that changes in the conductivity of seawater are easily detectable using this method.

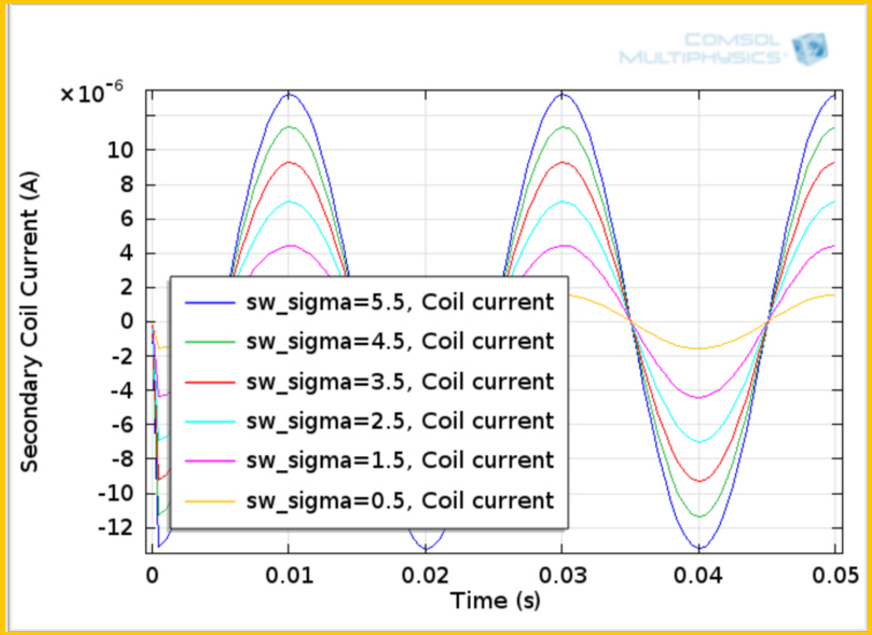

Figure 5. Secondary Voltage Vs. Conductivity

Conclusions

This model demonstrates that changes in seawater conductivity are readily measured with an inductive methodology.

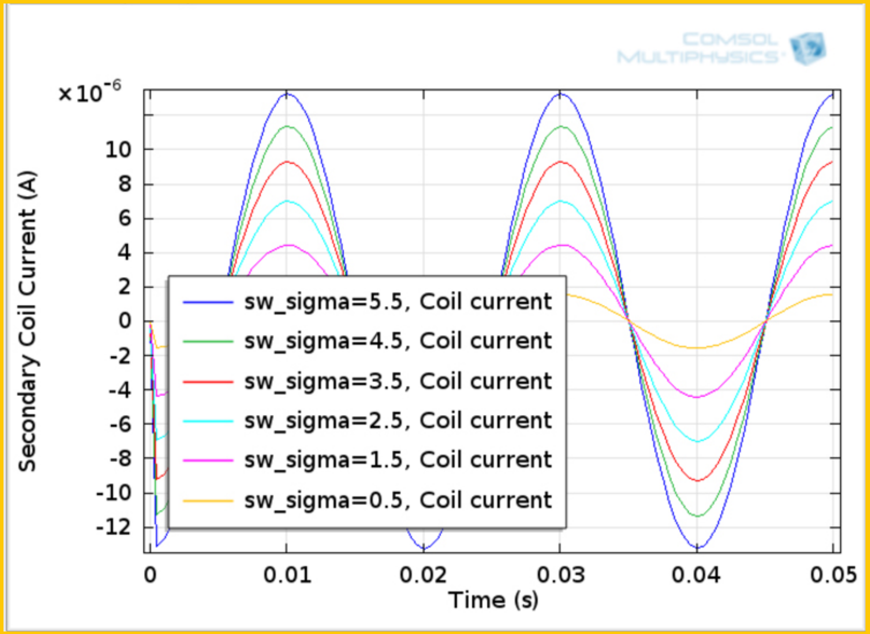

Figure 6. Secondary Voltage Vs. Conductivity

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Thank You!