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High Frequency Operation of Orthogonal Fluxgate Sensor Fabricated with Cobalt Base Amorphous Wire

Hwisoek Kim[1], Young-Hak Kim[1], and Kwang-Ho Shin[2]*

[1]Pukyong University, Pusan, Korea

[2]Kyungsung University, Pusan, Korea

*Corresponding author: e-mail: khshin@star.ks.ac.kr

We have investigated the output property and sensitivity of the orthogonal fluxgate sensor(OFG) composed with a cobalt base amorphous wire and a solenoid pickup coil. The sensitivity of OFG is typically proportional to its winding number N, cross section area of magnetic core A, and operation frequency f [1,2]. In the case of the sensor with small size, the f should be as high as possible to prevent reduction of the sensitivity. The sensor was operated in the frequency of 1.2 MHz, which is several tens times higher than ordinary fluxgate sensor, and its output voltage was measured with the bias voltage of 1～3 V. Figure 1 shows a photograph of the fabricated OFG. The sensor was fabricated with a CoFeSiB amorphous wire with the diameter of 80 μm and a solenoid pickup coil with 270 turns of Cu wire with 100 μm in the diameter. The length of pickup coil was 3.2 mm. The experimental results clearly showed the optimal bias voltage and/or current could be useful to improve the sensitivity and linearity of the sensor. Figure 2 shows the magnetic field dependence of output voltage in the case of that the bias voltage was varied. As shown in this figure, extremely large improvement of output was achieved with optimal bias voltage. The maximum sensitivity of fabricated OFG was 1.32 V/(V·Oe) without any amplification.

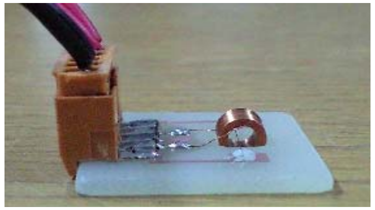

Fig. 1. Fabricated orthogonal fluxgate sensor.

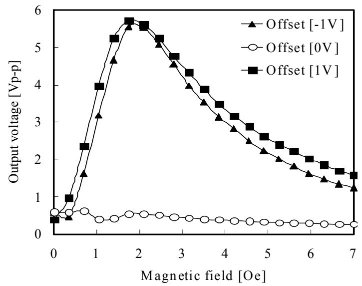

Fig. 2. Magnetic field dependence of output voltage.

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Reactance Change at Defect in Inconel Tube with Nickel Sleeving

Kwon Sang Ryu[1]*, Derac Son[2], Duck Gun Park[3], and Jae Kap Jung[4]

[1]Div. of Metrology for Quality Life, Korea Research Institute of Standards and Science,Daejeon 305-340, Korea

[2]Department of Physics, Hannam University, Daejeon 300-791, Korea

[3]Nuclear Materials Tech. Develop. Team, Korea Atomic Energy Research Institute, Daejeon 305-600, Korea

[4]Div. of Physical Metrology, Korea Research Institute of Standards and Science, Daejeon 305-340, Korea

*Corresponding author: e-mail: ryuks@kriss.re.kr

The steam generator (SG) tubes are used to transfer the heat generated by the nuclear fission in a primary loop to the turbine in a secondary loop. A metal-loss defects are partly produced in the SG tubes by the stress and the heat, because the SG tubes are used under high temperature, high pressure and the radioactivity. Tube wall defects, such as corrosion pits, acts as raisers, which lead ultimately to rupture[1]. So nickel sleeving is used for protecting the progress of metal-loss defect.

Eddy current technique (ECT) is currently the most widespread in-service technique used pre-service inspection of the SG tubing in the nuclear power industry. The metal-loss defects cause trouble for the safety of the SG tubes, but it is difficult to detect it in SG tube with nickel sleeving.

A new type of sensor is needed for detecting the metal-loss defects at the nickel sleeving SG tubes. It's principle is based on the measuring the change of impedance in B-sensing coil, composed of *U*-type yoke wound magnetizing coil and *B*-sensing coil, and *H*-sensing coil.

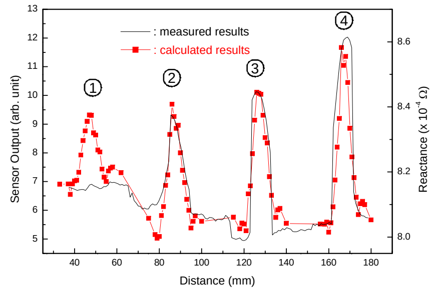

Fig. 1. Comparison the calculated results to measured results.

In this work, we calculated the reactance change by FEM for the new method detecting the defects in nickel sleeving tube. The reactance amplitude calculated for the defect existed in the Inconel 600 tube with nickel sleeving is well agreed to the results measured by the fabricated probe. The reactance was solved by the Ansoft Maxwell 11.1 3D software. The solver of FEM was eddy current, the number of mesh was 364,000 tetrahedra, and solving frequency was 10 kHz. The total current flowing in the magnetizing coil was 10 A.

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