UC11

Calibration system for low field magnetometer

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A calibration system of magnetometer has been developed at the Korea Research Institute of Standards and Science (KRISS). The system is composed of a precision quartz solenoid, nonmagnetic facilities, an Earth's magnetic field (EMF) compensation system, a current stabilizer and a ^{4}He atomic magnetic resonance (AMR) magnetometer.

The quartz solenoid had a 0.0101 m radius and a 0.938 m length with 1 mm pitch. To improve amagnetic field uniformity in solenoid, a multi-winding system was developed to ensure high uniformity. The solenoid is placed at the center of the three-component EMF-compensation-coil system.

The nonmagnetic facilities include a nonmagnetic laboratory, two auxiliary buildings, and a observatory building. These buildings are separated from each other to eliminate magnetic interference between the equipment operated in in the buildings. There are no other artifacts, such as buildings, roads, or electrical power substations within a radius of 50 m fromthe nonmagnetic facilities.

The main and auxiliary Helmholtz coils with a diameter of about 1.8 m and 0.9 m respectively, for EMF compensation consist of three orthogonal components. The Cs-AMR field controller is connected to one of the 3-axis Helmholtz coil. This system automatically compensates EMF variations within 0.1 nT/h in the solenoid axis direction.

The high-stability current source supplying the solenoid is achieved using a very precise magnetic field-to-frequency converter in the basis of ^{4}He metastable spin polarization through optical pumping of the Cs atoms.

The 4He AMR magnetometer is used for the magnetic flux density standard in tesla(T) to transfer to magnetometers under calibration. The experimentally measured coil-constant and temperature-coefficient of the solenoid are 1.231 060 5×10^{-3} T/A (25°C) and 3.8×10^{-7}/°C, respectively. The magnetic field is generated by the discussed above system is uniform to better than $5\cdot10^{-7}$ within ± 2 cm around its center. The stable magnetic field is maintained an uncertainty of 4 to 21 μT/T (k=2) in the range of from 0.02 mT to 1.2 mT.

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UC12

Nondestructive testing for metallic flaws using inductive head sensor and excitation single coil

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The role of electromagnetic-based non-contact and nondestructive evaluation (NDE) of metallic components in engineering industry is increasing [1, 2]. It has been mainly applied for inspection of metal constructions, pipes, parts of plains, and nuclear power plants, etc.. Among the electromagnetic based NDE, eddy current testing (ECT) probes combine an excitation coil that induces eddy currents in a specimen and a detection element that identifies the perturbation of currents caused by cracks or other defects.

Therefore, we have performed the nondestructive testing (NDT) to detect the metallic surface flaws using the simplified eddy current sensing system.

This eddy current testing (ECT) sensor was composed of the commercial tape recording magnetic inductive head as a sensing component and single coil with straight and circular shape as an excitation coil. The excitation coil was generated the AC magnetic fields with the frequency range of a few Hz to a few MHz which were applied to the artificial cracks specimen.

The sensor probe was moved on surface of the artificial cracks specimen with 4 mm of flying height and 4 mm/s of scan speed which controlled by x, y-axis scanner. The detected signals from inductive head were amplified and filtered by the Pre-amplifier and Lock-In amplifier, respectively, and then, modified to the differential wave form. The artificial crack specimens were prepared with the various shape of cracks (slit and hole), size (minimum depth and width; 0.5 mm) and materials (Al, Cu; nonmagnetic metal, Fe, FeC; magnetic metal), respectively. Fig. 1 a) shows the photo image of the typical artificial slit type crack which specimen is S45C carbon steel with the thickness of 5 mm, and Fig. 1 b) shows the measured output signal by circular type exciting coil with 27 kHz, and Fig. 1 c) shows the image of the defects using measured output signals. As results, the positions and shapes of surface crack in various metallic specimens were easily detected with high sensitivity by the inductive head ECT sensor.

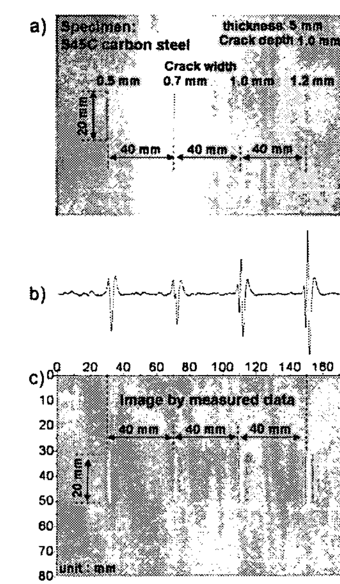

Fig. 1. The typical photo image of artificial crack specimen a), measured signal b) and image of crack specimen by output signal.

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